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THE SALE OF THE NORTH MANCHURIA  
RAILWAY

SAKATANI URGES PACT WITH RUSSIA

JAPAN'S ADVANCE IN METALLURGY

Vol. XXX

OCTOBER, 1934

No. 10

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# The Far Eastern Review

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## The Sale of the North Manchuria Railway

*In the following article an authority in closest touch with the situation in Manchuria presents an analysis of the offers of the State of Manchoukuo and the demands of Soviet Russia in the recent negotiations for the purchase of the North Manchuria Railway (formerly the Chinese Eastern Railway), which, according to current news reports, have, at length, concluded in the transfer of ownership of the railway to Manchoukuo. The writer describes Russian machinations for communizing Manchuria and discloses the extent of Russian influence in disturbances on the railways, as well as giving some facts relating to banditry generally. The comprehensive Soviet Russian military preparations on the Manchurian border are in marked contrast to Japanese military activities in this region. It is to be seen that in acquiring the Russian holdings in the line the price that the new State is paying is not so much for possession of a railway line as for the removal from Manchuria of Communism.*

\* \* \*

IN order to arrive at a fair and adequate understanding of the facts involved in the negotiations for the sale by Soviet Russia of its interests in the North Manchuria Railway (formerly known as the Chinese Eastern Railway) to the State of Manchoukuo, it seems necessary to go back to the Agreement entered into at Mukden between the Autonomous Government of the Three Eastern Provinces (Chang Tso-lin having declared the independence of his domain at that time) and Soviet Russia, on September 20, 1924, on which the status of the railway became based, when Soviet Russia decided to go back on its original promise to restore the railway to China without compensation.

Among the articles of this agreement are several to which reference may be made pertinently at this time, such as that to the effect that the future of the Chinese Eastern Railway shall be determined by the two contracting parties "to the exclusion of any third party or parties." This is important in so far as it prevents Soviet Russia from selling its interests to other nations. Other articles provide that the net profits of the railway shall be held by the Board of Directors and shall not be used before the question as to how to divide them can be settled; that employment of railway officials shall be in accordance with the principle of equal representation between the nationals of the two countries; that a Board of Directors shall be composed of ten persons, consisting of five from each country, seven constituting a quorum, and the consent of no less than six directors being necessary for making any decision.

It is also provided that "the concession period of eighty years mentioned in Article 12 of the Contract of August 27 (September 8) 1896, for the Construction and Operation of the Chinese Eastern Railway, shall be reduced to sixty years, upon the expiration of which the line with all its appurtenances will pass free of charge to the Chinese Government.

"The question of further reducing the aforementioned period of sixty years may be taken up for consideration with the approval of the two Contracting Parties.

"The Union of Soviet Socialist Republics agrees, upon the signing of this Agreement, to the redemption by China of the said Railway with Chinese capital, the actual and fair cost of which to be fixed by the two Contracting Parties."

During the years immediately following upon this Agreement the Soviet Russian officials practically controlled the railway through a very simple expedient. No Russian directors would appear at directors' meetings and consequently no quorum could be attained.

In the meantime the Russian manager carried out the actual management of the railway, mainly for the benefit of the Russians. The profits of the railway were placed in the Soviet Dalbank.

### Chang Tso-lin's Action

This state of affairs continued for some years while Chang Tso-lin was engaged in various intrigues and warfare south of the Wall, as he dared not show a strong hand against Soviet Russia for fear that it might menace his rear while he was engaged in fighting in the south. Later, however, during a lull in the hostilities south of the Wall, Chang Tso-lin ventured to assert himself, with the result that the railway was shorn of a number of important appurtenances, including all lands not directly employed for railway purposes, schools, telephone systems, and the river fleet (valued at \$3,000,000), wharves, etc. It was also arranged that the profits of the railway should be divided equally between Soviet Russia and the Chinese at regular intervals. The equal distribution of employment between Soviet Russians and Chinese was also insisted upon, but while this was effected as far as equality in numbers was concerned, the Soviet Russians continued to hold by far the greater portion of the key positions, this being largely due to the fact that the Chinese did not have a sufficient number of technically trained men to bring into such employment.

It is worth noting that the Soviet Russian officials are all Communists, with records which are absolutely satisfactory to Moscow in respect to past history and undoubted loyalty. When, in 1929, hostilities occurred between Soviet Russia and Manchuria, under Chang Hsueh-liang's régime, Moscow ordered all the Russian employees of the C.E.R. to cease work, but, as a matter of fact, only 2,000 obeyed the order, and as a consequence the railway continued to function fairly satisfactorily, whereas if all the Russians had obeyed orders, the railway would have been compelled to cease functioning. After this experience, Moscow discharged the employees who had not obeyed, and replaced them with Communists of unquestionable records and loyalty. The above-mentioned facts have a direct bearing on the state of the railway to-day and on the Russian activities in connection with recent disturbances.

Partly as a result of the system of division of profits at regular intervals, very little has usually been left for maintenance and repairs of railway property, and this is now in a very decrepit condition. The road-bed is extremely poor; most of the ties are rotten and most of the rails are old, and all of them are very light (the C.E.R. uses 64 lb. rails, whereas all the principal railways under the Manchoukuo State Railway Direction have much heavier rails); and the rolling stock is all old and nearly all of it obsolete. As a matter of fact, absolutely no new rolling stock has been provided since 1917. At that time a number of American locomotives and some cars of American manufacture (but paid for by the British) were shipped to Vladivostok, it being the intention to send them into Russia. At the time when this equipment arrived at Vladivostok, however, the Russian Government had fallen and the locomotives and cars were taken over by the Inter-Allied Technical Board, which at that time was running the Chinese Eastern Railway.

This fairly old rolling stock represents the latest acquisition of such by the N.M.R., and forms its most valuable equipment, but last year the Soviet Russian management contrived to send a large number of these locomotives and cars into Soviet Russia, where they remain, so only a portion of this good equipment

remains in Manchuria. The rest of the locomotives and cars are of such antiquated patterns that they would not be used in any modern railway to-day. Only some of the locomotives have air equipment and some of the cars of the shipment mentioned above, but the rest of the rolling stock, representing the vast majority thereof, is without air brakes and without automatic couplings. The cars have antiquated chain couplings and only four wheels, as compared with the modern bogey cars employed on all the rest of the railways in Manchuria. Owing to the weight and inefficiency of the rolling stock and the lightness of the rails, coupled with the poor condition of the sleepers and the road-bed, the whole system is absolutely inefficient, and that it works as well as it does is rather to the credit of the Soviet Russian technical men in charge, especially considering the fact that only a minimum is being spent on the repairs most absolutely necessary to have the railway run at all.

### What Manchoukuo is Buying

If the State of Manchoukuo purchases the railway it would, therefore, receive of material value only a dilapidated road-bed and equipment of which it would be necessary to scrap by far the greater part. The old bed would have to be repaired and new, heavier rails laid, which would be made to conform to the 4-ft. 8½-in. gauge, which is the standard of all other railways in Manchuria. This would cost at least Y.40,000,000. Of the present rolling stock the locomotives could not be used, as they would have to conform with the up-to-date standards of the other railways in Manchuria. Some of the passenger cars, which have air equipment, could be used by changing the wheel base, but all the freight cars and many of the passenger cars would have to be scrapped as they are not worth repairing. The railways shops are so poor that they would not be used.

As a matter of fact, the State Railway Direction has already had considerable experience with the converting of railways formerly under Chinese management to the modern standard which it insists upon, including unification of rolling stock and the like. Thus, the Direction originally took over 2,950 kilometers of railway lines and had to spend Y.30,000,000 on improvements during the first year, owing to past neglect, and during the following year a similar amount or more is being spent. These Chinese lines had some new rolling stock and the bridges and road-beds were in far better condition than are those of the Chinese Eastern Railway. These figures may serve to give some idea of the expense which will be involved in bringing the North Manchuria Railway (C.E.R.) up-to-date.

As a matter of fact, it costs the Manchoukuo State Railway Direction on an average of Y.100,000 to build a kilometer of railway. The cost is considerably less over flat land where no tunnels, bridges or heavy cuts are required, but higher where the terrain offers such difficulties. The average cost, as has been stated, is Y.100,000 per kilometer. Throughout the greater part of its length the North Manchuria Railway runs over flat plains, offering no difficulties. On the western line only the tunnel and loop constructed for crossing the Hingan Mountains have involved large expense, while on the eastern line some difficult territory is found. The southern line runs over flat country through its entire length. Therefore, it would be easy to construct an entirely new line paralleling the North Manchuria Railway line, with new road-bed and new rolling stock and all other necessary equipment at Y.100,000 per kilometer or even less, as it must be noted that the figures given for the Manchoukuo State Railway Direction railway construction include everything, road-bed, rails, bridges, etc., stations, rolling stock, and, in fact, every detail of equipment for a complete railway within the figure of Y.100,000 per kilometer.

The length of the North Manchuria Railway is 1,721 kilometers. It would, therefore, be worth if it were entirely new in every respect Y.172,100,000, as most of its valuable appurtenances were, as has been described, taken from it during the Chang Tso-lin régime and were never restored. A few timber concessions and some poor hospitals and minor factories are all that remains.

In view of the above described conditions it is interesting to examine the demands made by Moscow, and the bids made by Manchoukuo in connection with the railway negotiations. In this connection it must be remembered that Soviet Russia is not selling the entire railway. As a matter of fact, all it has to sell is in fact only a half interest for 22 years, as the railway, under the Agreement quoted above, is to return to Manchuria in 1956, without any

compensation whatever, and as during the remaining 22 years of that period Manchuria has a right to and has been collecting, one half of the proceeds.

### The Russian Offers

Moscow's first demand was for G.Rbls. 250,000,000, which is equal to Y. 625,000,000, and in addition to this Moscow demanded that Manchoukuo pay Y.30,000,000 for retirement allowances for the Soviet Russian employees of the railway. Under the system which has been in operation on this railway for many years a certain sum is deducted from the salary of each employee and held by the railway company until such time when the employee retires, when it is given to him in the form of a retirement allowance. These sums are, therefore, the property of the employees involved and represent a definite obligation on the railway. There is thus now due to Soviet employees a total of Y.30,000,000 and to Manchurian employees, Y.20,000,000, the difference in these amounts being due to the fact that the Manchurians usually occupy less well paid positions than do the Russians. The sum of Y.20,000,000 due to the Manchurian employees is thus just as much an obligation of the railway as is the sum due to the Russian employees, and as a consequence this also must be taken into account in figuring the sum which the Manchoukuo Government would be obligated to pay in case it should take over the railway.

It has been shown that new railways in Manchuria cost Y.100,000 per kilometer, but if one takes the Russian first demand figure of a total of Y.655,000,000 (leaving out the Y.20,000,000 due to Manchurian employees) this represents a value of Y.380,000 per kilometer, and as the Russians have only a half share to sell, this would place the total value at Y.760,000 per kilometer. This is, of course, an utterly absurd figure. Moscow evidently named this figure only in order that it might impress the uninformed outer world with its magnanimity when it subsequently reduced its demand to Y.160,000,000, plus Y.30,000,000 for the Russian retirement allowances. In this it has evidently been quite successful.

Let us now examine the final Soviet Russian figure amounting to Y.160,000,000 as a basic price, plus Y.30,000,000 for Russian retirement allowance and Y.20,000,000 for Manchurian retirement allowance, it being really necessary to include the latter figure, as the buyers will have to pay out this amount as an obligation which they will have to take over with the rest of the obligations on the railway. This makes a total of Y.210,000,000, which, figured on the basis of Y.100,000 per kilometer, makes a cost of Y.122,000 per kilometer, which, as Russia only has a half share to sell, actually represents Y.244,000 per kilometer.

Against this we have Manchoukuo's last bid of Y.120,000,000 for the railway, to which must be added the Y.50,000,000 due to Russian and Manchurian employees, making a total of Y.170,000,000 which come within just Y.2,000,000 of being exactly Y.100,000 per kilometer for Soviet Russia's half share, or a total of Y.200,000 per kilometer.

In other words, the Manchoukuo Government offers to pay for the Soviet Russian half share in a decrepit and antiquated railway, which would require at least Y.95,000,000 (Y.40,000,000 for road-bed and rails and Y.45,000,000 for rolling stock) to place it on a modern operating basis, a sum equal to that which would be required for constructing an entirely new railway, complete with brand new rolling stock and other equipment.

### A Question of Estimates

The maximum benefit which Soviet Russia can derive from the North Manchuria Railway will be its half share of the profits during the remaining 22 years of its rights in the railway. It is difficult to arrive at an estimate of what such profits are likely to be. In fact, it is impossible even to obtain figures on which both parties will agree with regard to the earnings of past years.

The Russians have taken the period from 1924 to 1930 inclusive as a basis for their calculation and claim that, on this basis, the average profits amount to about, Y.31,000,000 a year. These figures are contested by Manchoukuo as being a Russian exaggeration, but in any case the period mentioned includes the very best years of Manchuria's economic history, namely, the almost fabulous years of plenty when Manchuria was disturbed by neither floods nor armed conflict (except the ever-present bandits), when bean prices were extremely high, and when the railways made exceptional

profits. To-day the very low price of beans has had a serious effect on Manchurian economics and, consequently, on railway freights, especially on the N.M.R. which does not have the advantage of carrying the vast quantities of construction material which are being shipped through Dairen and the Korean ports and are bringing big business to the S.M.R. and Manchoukuo State railways.

The figures cited for the years mentioned are, therefore, not at all representative of present-day N.M.R. conditions. However, even if one accept this Russian basis of calculation, the total profit for the railway over a period of 22 years would be Y.682,000,000. From this must be deducted the obligation of Y.50,000,000 due to railway employees for their retirement allowances, leaving a total of Y.632,000,000. Of this Soviet Russia's half share would amount to Y.316,000,000, but it is very evident that the railway cannot possibly earn anything like these figures. In the first place, it cannot continue to operate much longer in its present dilapidated condition, and during the next 22 years it would be impossible to avoid the expenditure of large sums for major repairs, replacements and new rolling stock. The factor which will have by far the greatest effect on the earnings of the N.M.R. will, however, be the competition furnished by the new railways which have been built or will soon have been constructed by the Manchoukuo Government. Of these the Harbin-Lafa railway is already in operation and it is taking a great volume of business away from the southern line of the N.M.R. between Harbin and Hsinking. This is hardly surprising in view of the fact that the Soviet Russian authorities of the N.M.R. have always made it a point to charge exorbitant rates on this line in order to compel shippers to use the eastern line leading to their own port, Vladivostok. For instance, it costs more to ship a case of kerosene less than 150 miles from Hsinking to Harbin than it costs to ship the same case from the United States to Hsinking. In fact, the rates imposed by the Soviet Russian management are so exorbitant that even before the completion of the Lafa-Harbin railway, shippers found it to their advantage to send goods from Dairen to Harbin by way of Tsitsihar and then by the loop line to Hulan and Hailun to Harbin, in spite of the fact that this represents a tremendous difference in distance, the direct route distance being 944 kilometers and the indirect route measuring 1,723 kilometers. The line from Tsitsihar to Ssuping kai, on the S.M.R. line, has for some years past taken a very considerable amount of business from the N.M.R. Soon a new line will be opened from Hsinking to Talai, which will take a great share of the goods which have heretofore been shipped from the N.M.R. station, Anda, which is one of the most important points on the west line, and the new line running from Tumen to Mutankiang will furnish similar competition to the N.M.R.'s eastern line. These new lines will lead to the new ports on the Korean coast. Of these Seishin is already operating and Rashin, the main port, will begin operations next year. This port is ice free, whereas in winter Vladivostok can be kept open only by means of ice-breakers. Furthermore, Rashin will be furnished with the most modern equipment, which is lacking in Vladivostok, which latter port also suffers from the fact that under the Soviet régime the labor is extremely poor.

It is, therefore, inevitable that the N.M.R. will cease to be a main artery for traffic and will become practically entirely a local line acting as a feeder to the various new lines leading to the modern ports in Korea, which condition will be accentuated through the fact that the decrepit and old-fashioned equipment of the N.M.R., running over a road-bed and track in so poor a condition that it compels trains to run very slowly, will be hard put to compete with the new lines, with their new road-bed and thoroughly modern equipment.

### Earnings Must Diminish

It is, of course, impossible to predict what may be the earnings of the N.M.R. during the next 22 years, but, in view of the fact that the line is certain to lose an extremely large part of its traffic and that it will have to reduce its present exorbitant rates very materially in order to compete at all, it is not at all likely that it will be able to earn more than a fraction of what it earned during the rich years of plenty, which Soviet Russia has used as a basis for her calculation. Certainly, if Soviet Russia should accept the sum now offered by the Manchoukuo Government and bank it at even a conservative rate of interest, its returns at the end of 22 years would be far greater than they can possibly be if it does not accept.

It is, therefore, quite evident that when the Manchoukuo Government is making an offer which, if material property values

be considered, is absurdly high, it is doing so because it is paying not only for the material property, but also for the great political advantage which will be attained if the Soviet Russian Communist establishment in the heart of Manchuria can be removed by paying this price.

We now come to the matter of the numerous attacks which have been made on the N.M.R.'s trains by bandits, or persons operating in the fashion of bandits, mainly on the eastern line, but also in one recent case on the southern line, and to the allegation that Soviet Russians are implicated therein. With regard to this one hears the comment that it would be absurd to believe that the Russians would destroy their own railway and thus reduce its purchase value. Since Manchoukuo patently is paying largely for the removal of the troublesome Russian influence in Manchuria, it might not seem either fantastic or illogical for the Russians to find it advantageous to make as much trouble as possible, so as to heighten Manchoukuo's desire to remove them as soon as possible, and therefore raise their offer.

The point relating to destruction, in fact, amounts to very little. Through the *modus operandi* usually employed by the marauders a few rails are removed and the locomotive and the first few cars following it are upset. Even under the best of normal conditions the N.M.R. trains must operate at a notoriously slow rate of speed owing to the precarious road-bed and antiquated rolling stock, and it has been observed that in many of the cases of recent wrecks the trains slowed down just before reaching the point where the rails had been removed. Consequently the locomotive and cars fell gently over and were but little damaged. Anyway, the value of these antiquated trains is, as has been shown, extremely small. Certainly if one should total up the cost involved in replacing the rails, replacing the rolling stock on the tracks and add to this the actual value of such equipment as is damaged beyond repair, or the cost of repair to such as can be repaired, the amount would not come to a figure which could be an element in the negotiations, considering the large totals involved, and particularly the fact that Manchoukuo, in making its offer, is not giving much consideration to the value of the rolling stock which it would have to scrap, anyway.

To-day Soviet Russia is entering the League of Nations and has been recognized by the United States. She is being received abroad with the rejoicing which, in contra-distinction to the ninety-and-nine who are righteous, is given to the one who has not been so. In Europe and America it is believed that Soviet Russia has turned a new leaf inasmuch as she is not apparently continuing her obnoxious proselytizing and disturbing activities in Europe and America. Informed persons abroad must, however, know that the apparent cessation of such activities in Europe and America has by no means meant their cessation in Asia, particularly in China.

Outer Mongolia is already lost to China and is being used as a base for activities in adjacent regions. Soviet machinations in connection with the recent disorders in Sinkiang have been very evident. While, in China, plain banditry is undoubtedly often characterized as Communism, there is, however, absolutely no doubt but that vast communized areas in China are controlled by Communists who obtain not only inspiration but actual assistance from Russia. The technique has changed somewhat since the departure of Borodin and General Galen (alias General Bluecher), so that now actual Soviet Russians in person are few and inconspicuous in China, the work of spreading Communism being done now through Chinese trained in Soviet Russia.

### Regarding Possible War

It can easily be understood that Soviet Russia has resented the gradual but great diminution of its sphere of interest in North Manchuria. In fact, many have been surprised at the apparent passivity of Soviet Russia in this connection, this being explained by the fact that she did not feel herself in a position to risk armed warfare with Japan at this time. However, instead of chancing armed conflict, Soviet Russia intends to regain her sphere of influence by more hidden means, namely, by attempting to communize Manchuria. For many years past such activities on a minor scale had been in evidence, particularly along the north-eastern border, and more especially in the Chientao district, where Korean independence agitators and Chinese bandits, who have always found this mountainous district a good home, furnished excellent

material for communistic conversion. While the Agreement between Soviet Russia and Chang Tso-lin pledged the signatories "not to engage in propaganda directed against the political and social systems of either contracting parties," this has been largely disregarded by employees of the N.M.R., and the late Chang Tso-lin's hatred of the Communists was well known.

The Communist fisherman finds his best opportunities in troubled waters, and the disturbances which followed the 1931 incident have furnished him with just the kind of an opportunity which he can appreciate and utilize. Lawless elements are the best material from which to make Communist converts, and the bandit gangs have, therefore, been the ones whom the Communist agitators have employed, following the usual technique of trying to make as much trouble as possible to the "Imperialists" and "capitalists." As has been stated, Communism had already a fairly good hold amongst the lawless elements in north-eastern Manchuria, and, in fact, the C.E.R. people had for many years past what might be termed a practically respectable connection with bandits along the eastern line through the fact that they, as well as others holding timber concessions there, found it necessary to make it a practice to pay local bandit leaders annual sums, in return for which the bandits promised not to set fire to the timber in the regions in which they respectively prevailed, and also engaged to prevent other bandits from doing so. The Russians, therefore, can have had little difficulty in getting into touch with the bandits.

In all this, it is, of course, difficult to determine exactly which particular Russian elements are involved in specific cases. One has, for instance, the Soviet Government in Moscow and on the other hand the Third International, and the former has always maintained that it had no connection whatever with the latter, which has seemed to most persons a sort of distinction without a difference and a case of the right hand's being conspicuously ignorant of the activities of the left hand. One also has to consider the authorities at Habarovsk and may remember that General Bluecher, who now commands the armies in Siberia, is the very same, who under the alias of Galen, and as a partner of Borodin, was active in starting the wave of destructive Communism from which China is still suffering, so that it might be small cause for wonder if the same old technique should now be followed. In addition to this Soviet Russian terrorists who may be operating more or less on their own general principles, or rather the lack of such, with or without more or less direct connection in Soviet Russia, are known to exist amongst the personnel of the N.M.R. One has thus a varied assortment of unscrupulous elements who find it to their interests to make as much trouble as possible. A number of arrests of Soviet Russians has been made and also of Chinese Communists, communists operating as bandits or bandits who are communists. These cases are now under investigation and until this shall have been concluded many, and the most important, facts cannot be disclosed. It is, however, possible to give some indications to show how it is possible to connect communist activities with the disturbances along the Chinese Eastern Railway.

### Distinctions in Banditry

In the first place, it is necessary to draw a distinction between bandits pure and simple, who operate entirely for loot, and between Communists who, while they may adopt the methods used by bandits operate entirely or mainly for political reasons. It is, therefore, very significant that, whereas banditry has decreased to a very striking extent along the railways operating under the Manchoukuo Railway Direction, attacks on railways have increased very considerably in the regions close to the Siberia territory and in the Soviet Russian sphere closest to Russian territory, especially on the eastern branch of the North Manchuria Railway. The statistics show that 1,500 so-called "bandit" cases occurred on the railways which have come under the Manchoukuo Railway Direction, during the year prior to March 1, 1933, which is the date when the Direction was established. The following year 147 cases occurred and during the six months of the present year only 40 cases have occurred (It must be noted that such official statistics, unfortunately, include as "banditry" all cases of interferences, great and small, on the railways, classifying as "Banditry" even such minor matters as stealing of telegraph wires, placing stones on the tracks, burglaries on the railway property, and the like, so that the totals usually give a much exaggerated idea of the actual state of affairs). Out of the 40 cases mentioned, only three were actual attacks on trains,

and of those only one was a regular passenger train, where a slight derailment occurred and the bandits were easily beaten off by the guards. In no case was there any casualty to passengers, and, in fact, during this period no passenger has been either killed or wounded on the entire Manchoukuo Railway Direction system, which includes all railways in Manchuria except the C.E.R. and the S.M.R., and the latter's trains have been entirely free from attack.

(In passing, it may be noted that while some Britons, Americans and one Dane have been kidnapped by bandits during the Manchoukuo régime, the release of all of them has been effected by the Manchoukuo and Japanese authorities. This is a striking contrast to what has been, and is, the case in China, where the authorities have usually proved either ineffective or unwilling in the numerous kidnapping cases occurring there. For instance, the Rev. Bert Nelson (American) has been held by bandits, within less than 100 miles of Hankow, for well over three years).

It is also significant that, whereas in the past the most troubled zone was in the region between Hailungcheng and Mukden, this sector has now become very quiet and the section between Tunhua and Tumen, which is near the Russian border, has become the most troublesome.

Abundant evidence is at hand, showing that Communist activities are increasing in this area and that greater efforts are being made to spread Communism. The writer has seen a number of circulars, which have been confiscated, containing violent communist propaganda. These circulars are very simple and are largely pictorial, so that they may be understood even by ignorant persons. They show pictures of Japanese and Manchoukuo soldiers, hideously featured, violently driving naked Chinese out of the villages into the rivers at the point of bayonets. The text promises that all property of "Puppets of Japan" will be confiscated and distributed to the right-minded people, and are signed by the "Chinese Communist Party" of such and such a region, according to the place where these circulars are distributed. In these Communist bandit groups have been found Russians, but far more numerous are the Russian-speaking Chinese who have received their Communist education in Soviet Russia. One of the circulars which I saw was particularly interesting in that it showed absolute evidence of its Russian origin. In the picture one of the Japanese was shown carrying a flag intended to represent the flag of the Manchoukuo Railway Direction, but instead of this symbol the circular showed the Russian character "ph,"  $\Phi$ , similar to the Greek "Phi," which somewhat resembles the Manchoukuo Railway Direction emblem, indicating that a Russian author had made this very easily explainable mistake.

### On the Subject of Bandits

As bandits have been mentioned here, it may be well to make a slight digression on this subject. It had been expected that a temporary increase in banditry cases would be likely to occur owing to the fact that the Japanese troops, which had been scattered widely over the countryside, had largely been withdrawn to their main bases, in order that they might be drilled in larger formations than was possible when they were so scattered, leaving the suppression of banditry to the Manchoukuo armed forces. Furthermore, as a large number of arms had been taken up from the civil population in order to prevent the bandits from having access to such a supply, it was expected that for a while this might encourage the bandits. Finally, during recent months, the kaoliang reached its maximum height, a fact which always leads to increase of banditry owing to the excellent shelter which it affords.

The fact that practically all the very large groups of bandits have been broken has led to the formation of a number of much smaller gangs. The total of bandits has been much reduced, but the number of small gangs has been increased. As a consequence, whereas when a big group makes a raid this constitutes only one case of banditry, raids by a number of small groups naturally constitute a large number of cases numerically, although the actual effect is, of course, much less. As a matter of fact, the Japanese military authorities have come to the conclusion that it is necessary for them to go into action again against the bandits, and several large scale operations are about to be undertaken in order to clean up the districts where trouble has occurred. The bandit activities, however, are taking place further away from the Manchoukuo Railway Direction lines, which have become much more free from trouble. Thus, last year a number of persons were killed or wounded

along these railways, including both railway employees and passengers. This year there have been no casualties among railway passengers, though a few passengers on business have been injured, and the total of railway employees and bus passengers killed and injured this year is only 15.

For attacks on trains and other property on the Manchurian railway lines, undoubtedly both professionals operating entirely for profit and persons employing bandit methods but having mainly political ends in view have been involved. Quite possibly groups have also been engaged which combined political and mercenary aims. Those having political or mixed aims have been responsible for the greater number of attacks. A number of arrests have been made of Soviet Russians, including those alleged to have been preparing an attack upon the Japanese military mission at Pogranichnaya, others accused of furnishing assistance to bandits and groups acting like bandits, and still others accused of organizing Communist groups among the local population. A number of those arrested are employees of the North Manchuria Railway, and while, as has been stated, definite instances of evidence cannot at this time be published, as these cases are still under investigation, it is still possible to give a general outline of some of the facts which indicate that purposes other than plain banditry and loot were involved in many of these attacks.

For instance, the trains attacked were principally those carrying military supplies and, while ordinary bandits would have taken such supplies away, as this obviously is the purpose of banditry, in most of the cases mentioned the goods were burned, but not taken. Cases have also been numerous where Soviet Russian train men have jumped off the trains just before they arrived at the places where the rails had been removed, indicating that they had advance information. It is claimed that others have been seen signaling to the attackers in ambush. While on these trains persons of other than Soviet Russian nationality have been attacked, Soviet Russian nationals have been conspicuously free from attack. Evidence has been found that train despatchers have acted in collusion with attacking groups. The Japanese military have in many cases insisted that cars carrying their supplies be placed in the sections of the trains where they would be in least danger, and this has been done when the trains left Harbin, only to have the make-up of the trains changed when they had arrived at places further east on the line, usually at Imienpo, when the Japanese military supply cars were carefully placed where they would be the most liable to damage. In many cases the derailments have been so arranged that the damage to railway equipment would be as small as possible. Repair trains have arrived with suspicious promptness at places where attacks have been made. Hidden wireless installations have been found, which were in communication with Khabarovsk, and in cellars of houses occupied by Soviet Russian railway employees printing presses have been found, which have been used for turning out Communist circulars such as have been already described. Certain other definite evidence, including confessions and admissions by arrested persons, which has been obtained is far more clear than that which has been generally described above. It will, I am sure, when it becomes possible to disclose it, convince even the most critical.

### Preparations for War

While an underground battle is thus being fought against Manchoukuo and Japan for the purpose of undermining their influence by communizing Manchuria, the more visible elements of potential friction do not seem to carry danger of actual armed conflict between Soviet Russia and Japan. It is, however, very conspicuous that Soviet Russia is building permanent defenses all along the Amur, while a new style of permanent forts, connected by underground tunnels, is being built on the Pogranichnaya front, at the confluence of the Amur and Sungari, at Blagoveshchensk, and, further from the frontier west of Manchouli, at Dauria and Borzya. These fortifications are formidable works involving an expense of many millions of dollars. The Trans-Siberian Railway has been double-tracked to Chita and half the way from there to Blagoveshchensk, and preparations have been made to double-track the rest, work on the new bridges having already been commenced.

That Soviet Russia should now feverishly erect such elaborate defenses along this long frontier, at great expense, may, however, not be regarded as altogether too surprising or disturbing. Until

recently, when Soviet Russia faced only the forces of the Chang régime, it obviously had little need of such an elaborate military establishment, as was demonstrated in 1929, when less than 5,000 Russians crossing the frontier into Manchuria easily defeated the Manchurian armies of several hundred thousands. Now, when Japan has undertaken the defense of Manchoukuo, Soviet Russia may believe that a far more powerful potential enemy is to be faced. It is, however, a little less easily explainable that Soviet Russia should find it necessary to place in Siberia numbers of troops far in excess of the number which would be needed for the manning of the defense works, as, for instance, three full divisions at Chita, two to three at Blagoveshchensk, two to three at Nikolsk and Khabarovsk, and so forth, making a total of probably over 200,000 armed men. West of Baikal there are twelve to thirteen divisions of infantry, two divisions of cavalry, five to six thousand tanks and five hundred to six hundred airplanes, and a very considerable quantity of artillery.

It is difficult to see, under these circumstances, why apprehension should be felt abroad that hostilities may be initiated by Japan, which has erected no fortifications on the Amur and which, as a matter of fact, has actually decreased the number of its troops in Manchuria since last year, so that they now number only about 50,000, while Soviet Russia is making such elaborate war-like preparations. On the contrary, while Japan is not adding greatly to her Manchurian forces, in spite of Russia's warlike attitude, but is reducing such, should be reassuring.

It is possible that such suspicion is the reaction of those who believe that Japan, having embarked on military action in Manchuria, is looking for further worlds to conquer, but, as a matter of fact, a better theory, which happens to be the true one, is that Manchoukuo has performed the function of a safety valve, which is furnishing a field for Japanese activities which will demand their full energies and resources. If Japan had wished to fight Soviet Russia, she would undoubtedly have done it before Russia had completed her vast preparations in Siberia instead of allowing these to be carried on right under her nose. The fact is, of course, that Manchoukuo will furnish a more than adequate field for all the funds which Japan has to spare and that she could not easily afford, not only a campaign against Russia, but also the tremendous sums which would be necessary for the holding and development on Siberia, if she should be victorious.

It is well known that the best authorities on Soviet Russia (of which the writer certainly does not claim to be one), hold that Soviet Russia does not at this time contemplate war with Japan owing to the uncertainty that she must feel about the issue, and to the fact that it would interfere with her present industrial program, on which she has staked her entire future, to such an extent that it would probably wreck it, while, furthermore, political repercussions would be likely to cause much trouble to the present régime and might possibly cause its downfall. It, therefore, does not seem likely that such a war will occur in the near future, even though irritating instances, such as violations of the frontier, flying of Soviet airplanes over Manchoukuo territory, and above all, the Communist activities, do create a most unpleasant situation. On the other hand one has such reassuring developments as the recent conclusion of an agreement between Soviet Russia and Manchoukuo for the improvement and control of navigation on the Amur, and the resumption of the N.M.R. negotiations.

### Automatic Phone for Peiping

Acting on the instructions of the Ministry of Communications in Nanking the Peiping Telephone Administration is making preparations for the installation of the automatic system in Peiping.

According to tentative plans, automatic telephones will be installed in the East City first. An order for 3,000 of these telephones, costing about \$170,000 is reported to have been already placed by the Ministry of Communications for the local administration.

Between 1925 and 1927 the administration had over 28,000 subscribers. This number decreased sharply after the removal of the capital to Nanking in 1928. During the last few years the business of the company has shown a steady improvement. It is estimated that the administration has now about 18,000 paying subscribers.

# Japan's Advance in Applied Metallurgy

(Following is an interview recently published in American newspapers that was given by Mr. James A. Rabbitt, Adviser to the Japan Nickel Information Bureau at Tokyo, Mr. Rabbitt has just returned to Japan after a tour of inquiry that took him to Europe and through the United States and Canada).

\* \* \*

JAPAN'S phenomenal advance in Western industrialization, and as a world power, during the past sixty years is well known, but her recent success in producing high quality products at low cost has startled the world. That this success is based upon scientifically sound economic principles has been brought out in an interview with James A. Rabbitt, formerly Commercial Attaché to the American Embassy in Tokyo and at present Adviser to the Japan Nickel Information Bureau at Tokyo. Mr. Rabbitt has been on one of his periodic visits to the United States and Europe by which he keeps in touch with Western scientific advance in metallurgy.

Mr. Rabbitt states that Japan started on the road to recovery from the world depression one year earlier than the United States, and is carrying out a sane policy of economic development without making any drastic political changes. All industries have shown exceptional increases in production during the past two years. Steel and shipbuilding are typical of the general advance:

Steel	1931	..	..	1,559,000 tons	
	1932	..	..	1,891,400	..
	1933	..	..	2,484,900	.. —increase 58% over 1931.
Shipping—Scrapped	..	..	..	400,000	..
Built	..	..	..	200,000	.. —since October, 1932

New plan to scrap and rebuild 500,000 tons with Government subsidy.

The advance in industry has been reflected in the Nation's foreign trade:

	Imports	Exports
1931	Y.1,231,734,095	Y.1,121,580,091
1932	1,427,458,091	1,365,812,488
1933	2,017,503,919	1,932,069,187

It is a well known principle that a chain is only as strong as its weakest link. Strangely enough the weakest link in the industries of some countries to-day is their backwardness in research. Normally research development should be from three to five years in advance of a nation's industries. This has been true of the United States and should continue so unless the spirit of progress is killed by restrictions to output. It was particularly true of Germany before the Great War, but at present scientific research has been killed by political unrest.

In the Soviet Union research is woefully lacking, but the improvement in Japan's economic position has been based on a simultaneous advance in research and applied metallurgy. The advance of Japan's modern industrial civilization has created a demand for higher speeds to such an extent that the materials used to attain the lightness required for the manufacture of aeroplanes, automobiles, speed boats, rail cars and the like have had to withstand stresses and strains hitherto unknown. The result has been the development of a great number of new alloys having properties to meet almost any need. The very basis of the rationalization of modern industry depends upon the correct use of alloys.

In some cases there is need only for an increase of strength with hardness or lightness, in others toughness with ductility is required, or, all of these attributes may be required in one alloy. In other cases it might be necessary to provide electric resistance, or resistance to heat and/or corrosion; or, again, beauty of appearance might be the main property desired. In any event, the metallurgist, like the physician with his remedies, writes a prescription to meet the individual case.

The principal alloying elements for metals are:

For Strength, Toughness, Hardness.	{	..	..	{	Nickel, Chromium, Molybdenum
					Vanadium and Manganese.
For Electric and Heat-Resistance.	{	..	..	..	Nickel, Chromium and Iron

For Resistance to Corrosion from Acids, Salts, and Alkalis.	{	..	..	Nickel, Chromium and Copper.
For Lightness with Strength.	{	..	..	Nickel and Aluminum.

There are so many combinations of these alloying elements that it is almost impossible to list them. In fact new alloys are constantly being discovered. Among all of the alloying elements nickel is used most extensively because of its solubility with other metals at high temperatures, which has been compared to that of sugar in water; and because of its ability to impart not only its own superior properties to whatever metal with which it is combined, but also to raise the quality of the resultant alloy.

In 1903, the consumption of nickel was practically limited to four major items in industry, that is, to plating, nickel-silver, coinage and nickel steel (the latter used principally for military purposes). The present (1934) consumption includes twelve major items, as follows:—

(1) Nickel Alloy Steels	For Automobiles, Aircraft, Marine Engineering, Power Equipment, General Machinery and Ordnance
(2) Nickel Alloy Cast Iron	For General Machinery of all Kinds
(3) Ferro-Nickel Heat and Corrosion	For Furnace Parts and Chemical Equipment
(4) Nickel Chromium Electric-Resistant Alloys	For Resistance Elements in Electric Heating Devices
(5) Nickel Plating	For All Services including the base for Chromium Plating
(6) Nickel Catalysts	For The Hydrogenation of Fatty Oils
(7) Monel Metal and Stainless Steel	For Food Equipment, Chemical and Dyeing Apparatus
(8) Malleable Nickel	For Radio and Telephone Equipment
(9) Nickel Silver	For Architectural Ornaments and Fittings
(10) Nickel Coinage	Used in fifty countries.
(11) The Edison Storage Battery	For Mine Cars and Other Services
(12) Nickel Brasses and Nickel Bronzes.	For Marine Hardware, Propellers, etc.

It has been stated that "the need for nickel in industry is as great as that of salt in food." The development of modern alloys in Japan is of quite recent origin, although alloys were known to Japan's metallurgists in ancient times. This is proved by the great Daibutsu at Hara which was cast nearly twelve hundred years ago and contains:

1,154,097 lbs.	Copper
20,385 ..	White Metal
4,866 ..	Mercury
966 ..	Green Gold

This is beyond doubt the World's greatest example of advanced metallurgy in a period in which Europe was in the Dark Ages. But the development of modern alloys was somewhat retarded in Japan owing to the high cost of materials in that country and the low cost of labor. There is a well known principal in industrial economics that where labor is cheap and material scarce (as in Japan) labor will be wasted and material conserved; conversely, in countries where labor is expensive and material cheap (as in Western Industrial countries) labor will be conserved and material used freely.

The industrialists of Japan have now realized that for meeting world competition the same high strength and light weight alloys, as are used in Western industrial countries, must be used also in the products and processes of the industries of Japan. This has been known to Japan's men of science for a long time. Dr. Honda and his able staff of the Imperial University have done wonderful work in scientific research in metals, leading the world in the discovery and development of permanently magnetic steels.

The establishment of the Nickel Information Bureau at Tokyo, in 1932, provided a medium for bringing applied research for metals to the industries of Japan. The work of the Bureau is purely technical and it has for its Advisory Board many of the leading

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# Sakatani Urges Pact with Russia

CONCLUSION of a non-aggression treaty between Japan and the U.S.S.R. is suggested by Baron Yoshiro Sakatani as a simple and effective means of removing the war threat from the Asiatic continent. Baron Sakatani, former Cabinet Minister, former Mayor of Tokyo, and an outstanding exponent of and worker for international peace, makes the suggestion in an article on the international situation which he has written for *The Japan Advertiser*.

Most important of the terms suggested for such a treaty by the Baron are mutual abandonment of defense works along the frontier between Manchoukuo and Siberia, and withdrawal by each nation of its troops to a specified point. His article, entitled *Peace of Asia*, follows:

By Baron Yoshiro Sakatani

The question, how can we best bring about the peace of Asia, has been in my mind for some time, and I have been waiting for an opportune hour to answer that question. Since the U.S.S.R. joined and became a powerful member of the League of Nations, which I believe to be the greatest peace machinery human mind ever conceived, I feel the hour has now come for me to openly express my views on the subject in question and appeal to the statesmen of Japan and U.S.S.R. for their serious consideration of this important problem.

As we examine the map of the world, we can observe that Europe, South America and Asia harbor, every one of them the danger of a possible war in the future, while Africa, Australia and North America may be considered as a safety zone.

For the time being, let us set aside the question of Europe and South America, and turn our attention to the peace problem of Asia. At first glance the problem seems to be hopelessly complicated, but in reality it presents itself as one easy of solution.

What appeals to every thinking man to-day is the risky relationship of three countries—Japan, Manchoukuo and Soviet Russia. We cannot help but believe that this relationship is being more and more strained in these days, and the cause for this sombre situation is traceable to Russia's suspicion, ever since the Manchurian event, of Japan's encroachment upon the Far Eastern territory of Russia. When one sees that Russia is kept busy mobilizing her military forces to the Far East; constructing strong fortresses along the region bordering the boundary line between her and Manchoukuo; and placing powerful aircraft and submarines in Vladivostok, it is quite natural to form an opinion that Russia is nervously preparing for a war. Looking at this ominous state of affairs, Japan and Manchoukuo are tempted to believe that Russia may pounce at any moment and that they must be prepared for an emergency. Here it is clear that the minds of the peoples of the three countries are strongly tinged with distrust and suspicion which breed devilish phantasms and numerous calumnies. Under the circumstances, it is quite natural for outsiders to size up the situation as though a war in the Far East were imminent.

## Remedy Suggested

Are we able to find any effective remedy for the improvement of the situation. We believe we can find one in forming a non-aggression treaty between the parties concerned—a treaty which was once proposed by Russia but to which the Foreign Ministry of Japan dissented as premature. We shall lay down the following conditions as the principles of a non-aggression treaty:

- (1) Mutually to abandon the defense works in the regions bordering the boundary line between the two countries of Russia and Manchoukuo.
- (2) Russia shall withdraw all her troops to the west of Lake Baikal, except those that are necessary for the protection of the peace and order in the regions just mentioned.
- (3) Japan shall withdraw all her armies from Manchoukuo proper, except those needed to safeguard Manchoukuo and protect Jehol, and its vicinity bordering China.

- (4) Russia and Japan shall cooperate for their best interests to immunize the Japan Sea and Saghalien Island from the war menace in case either Japan or Russia is attacked by an outside country or countries.

To conclude such a pact as above mentioned will be a simple matter, and yet benefits accruing therefrom to both nations will be immensely great. I well remember that happy relations between the two nations really existed after the Russo-Japanese War. As I was one of the Cabinet members of Prince Saionji after the war just referred to, I know what I am talking about.

Indeed, the post-war relations between Japan and Russia were very cordial. Russia showed every courtesy to Japan. She not only faithfully fulfilled every condition laid down in the Portsmouth treaty, but also manifested good will to Japan in the Korean question later on.

## Virtual Alliance Existed

The most powerful figures of Russia in those days were Mr. Stolypin and Mr. Kokovtsev, whose policy for Russia was to look after her interests more in the West. Russia's policy toward the East under their leadership was nothing short of a Russo-Japanese alliance. I met those gentlemen in the then capital of Russia in 1908. But after the revolution in Russia, the state of affairs completely changed. The first thing that happened was the complete shipwreck of international faith of Russia, followed by Red propaganda; by the necessity of Japan's sending her expeditionary troops to Siberia at the invitation of the United States of America, and by the deplorable event of the Nikolayevsk massacre. Thus, the friendly relations between the two countries were damaged by various changes, going from bad to worse.

So far as Japan was concerned, she never entertained any ambition detrimental to Siberia. If Japan sought any profit from Siberia, it was in connection with the question of fisheries, which was clearly defined by the treaty between the two countries, Japan enjoying her legitimate share. Therefore, if Russia casts away from her mind suspicion of Japan, and instead cherishes a sincere desire to form a non-aggression Pact with Japan, the relations of the three countries involved will be firmly established in peace, which in turn will serve to wipe out the poisonous air of restlessness from the entire domain of Asia. This may not necessarily contribute to stabilization of the political turmoil in China, but China's difficulty is domestic, and it will not be hard to quell any international trouble from that side, even if it may occur.

I have not a slightest doubt that, regardless of race or nationality, those who care for humanity; love peace; wish to save the millions of Japanese, Manchurians and Russians from the horrible bloodshed of war; intend to bring about the prosperity of the whole world; and earnestly seek to increase the happiness of the entire mankind, will endorse this, my view, here expressed.—*The Japan Advertiser*.

## Japan's Advance in Applied Metallurgy

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scientists, educators and statesmen of Japan. The Bureau is co-operating with similar bureaux in other countries in the dissemination of scientific and practical information for the use of alloys in industry. Since its establishment, the Bureau has given technical research service in over one thousand cases, and has answered over fifteen thousand requests for technical information on alloys. It has published 28,000 copies of its quarterly *Review* and 63,300 copies of its technical publications, all of which have been bi-lingual, in either English-Japanese, French-Japanese, or German-Japanese. During the period in which this service has been rendered gratis to the industries of Japan, the consumption of nickel and other alloying elements in Japan has trebled.

# Coal Deposits in Shantung, China

**A**MONG the provinces in China where coal deposits are abundantly located is Shantung, whose reserve is estimated at about 1,670,000,000 tons. During the prosperous days the annual output turned out by the collieries in Shantung exceeded 2,000,000 tons, representing 10 per cent of China's total production, but in recent years, partly owing to the general economic depression and partly to the keen competition of the imported coal, has reduced to approximately 1,000,000 tons, half the previous amount. The coal deposits are widely scattered in various parts of the province, the more important ones being the Tzechuan, Poshan, Changchui, Ihsien, Laiwu, Hsintai, Tancheng, Tenghsien, Ningyang, Taian, Linchi and Feih sien. There are more than 100 places, to which licences have been issued for carrying out mining operations, with an aggregate area of 1,200,176 ares, of which 1,058,983 ares have been actually worked, the balance, 141,193 ares, having been exploited only.

The area of coal deposits in various districts of the province is listed below:—

		Ares			Ares
Tzechuan	..	1,100,012	Ningyang	..	59,862
Changchui	..	319,205	Laiwu	..	34,324
Hsintai	..	38,321	Itu	..	21,892
Taian	..	63,700	Linchi	..	13,164
Tenghsien	..	29,126	Penglai	..	1,816
Mengyin	..	9,449			
Feih sien	..	6,338	Total	..	2,100,277
Poshan	..	403,068			

A recent investigation into the coal deposits in Shantung puts the figure at 1,671,000,000 tons, with those of Tzechuan and Poshan the largest. Mining work on these deposits have been continued for about 400 years, and not many beds are now left untouched. Judging from the existing conditions, the Poshan deposit will be exhausted in no more than 40 years, and in a few places working can be carried on only for a period of about 10 years, according to some technical experts. The deposit of Changchui is estimated at 260,000,000 tons, about 20 per cent of the total in the Province, but on account of the fact that the coal has more ash content, working has not been carried out intensively. However, this coal is very suitable for use in furnaces, and when the Tien Yuan Mining Company was operating, the output was in good demand in Shanghai, Tsinan, and other districts along the Kiaochow-Tsinan Railway. Therefore attention will probably be first given to this deposit for working, when those of Tzechuan and Poshan are exhausted. With regard to quality, the deposit of Ihsien is considered as the best, with those of Hsintai and Mengyin next, the total reserve of the latter, according to a Japanese expert, being estimated at 300,000,000 tons. But owing to communication difficulties, only two small concerns, the Hsin Yu and Teh Tai are now operating in these districts with a daily output of about 100 tons, sufficient only for local consumption. Before the completion of extension of a branch line extended from the Kiaochow-Tsinan Railway to these districts, large-scale operations are not possible. Detailed figures concerning the deposit of various districts are as follows:—

		Tons.			Tons.
Ihsien	..	119,000,000	Hsintai	..	57,000,000
Tzechuan and Poshan	..	890,000,000	Weihsien	..	52,000,000
Changchui	..	260,000,000	Others	..	67,000,000
Laiwu	..	138,000,000	Total	..	1,671,000,000
Feih sien, Linchi, and Tancheng	..	88,000,000			

As stated above, the coal output in Shantung has now been curtailed by about half the original amount. The tonnage produced during the past 13 years ending 1930 is tabulated below:—

		Output (Tons)	Percentage of China's Total Output			Output (Tons)	Percentage of China's Total Output
1918	..	1,002,729	—	1922	..	1,166,704	11.8
1919	..	1,114,729	9.4	1923	..	1,494,528	9.8
1920	..	1,363,246	10.0	1924	..	1,643,381	9.5
1921	..	1,374,544	10.7	1925	..	1,571,312	10.0

		Output (Tons)	Percentage of China's Total Output			Output (Tons)	Percentage of China's Total Output
1926	..	2,212,338	9.6	1929	..	1,073,661	—
1927	..	1,634,015	6.8	1930	..	1,459,617	—
1928	..	1,157,488	4.6				

In regard to the output of the various districts, Tzechuan and Poshan have the largest share, as a considerable number of collieries are operating there. Next in the order of importance, are Ihsien, Changchui, Weihsien, Hsintai, and Mengyin. In Tzechuan, Poshan, and Ihsien an annual output of over 300,000 tons are produced respectively, in Weihsien and Itu, 50,000 tons each, and in Ningyang and Hsintai, between 30,000 and 20,000 tons. The production in other districts amounts to a few thousand tons only. The following table shows the tonnage produced in 1928, 1929 and 1930 in the various districts:—

		1928	1929	1930
Tzechuan	..	574,730	395,832	423,688
Poshan	..	509,111	436,361	460,000
Ihsien	..	—	102,650	355,501
Weihsien	..	96,015	46,126	55,320
Itu	..	23,282	10,404	93,070
Ningyang	..	31,885	46,733	41,428
Taian	..	9,653	7,387	10,000
Changchui	..	5,905	390	400
Laiwu	..	2,477	6,148	8,000
Hsintai	..	329	3,517	4,000
Mengyin	..	310	—	—

The coal deposit in Shantung is composed chiefly of bituminous coal, except in Linchi and Laiwu where anthracite is located. The coal from Ihsien is best in quality, usually two tons being equivalent to three tons of Japanese coal in efficiency. The following is a chemical analysis of the coal of the Chung Hsing Colliery, Ihsien.

		Lump	Dust	Unwashed	Coal from Small Shaft
Water Content	..	0.590	1.050	0.646	0.420
Volatile Matter	..	27.957	27.312	27.186	28.232
Fixed Carbon	..	62.303	60.905	62.215	64.299
Ash	..	9.150	10.749	9.953	7.050
Sulphur	..	0.582	0.601	0.623	1.456
Phosphorous	..	0.014	0.015	0.014	0.092
B. T. U.	..	14.021	13.662	13.860	13.860

Among the deposits along the Kiaochow-Tsinan Railway, the coal from Tzechuan and Poshan is the best known, but is not suitable for making coke, only about 10,000,000 tons deposited in Hsiho and Heishan being fit for coke-making. According to an analysis made by the Ministry of Railways in 1932, the chemical composition of the coal deposited along the Kiaochow-Tsinan line is as follows:—

		Water Content	Volatile Matter	Fixed Carbon	Ash Content	Sulphur	B.T.U.
<i>Poshan District—</i>							
Iron-melting coal	..	0.65	14.38	72.39	12.12	0.69	7.392
Gravelly coal	..	1.22	9.36	77.74	11.68	3.48	7.150
Sulphide coal	..	0.93	12.65	77.89	8.52	3.24	7.091
Oil coal	..	1.22	10.75	81.87	6.14	0.57	7.934
Coking coal	..	1.08	8.85	81.46	8.61	4.29	7.480
<i>Tzechuan District—</i>							
Sample A	..	0.81	8.41	72.01	18.77	1.18	7.333
Sample B	..	0.82	15.99	71.45	11.74	0.90	6.060
Sample C	..	0.87	12.66	75.57	10.90	1.17	7.657
Sample D	..	0.82	12.72	80.99	5.47	0.59	8.153
Sample E	..	0.88	13.47	68.18	17.47	0.89	7.471
Sample F	..	0.97	13.75	77.97	7.31	1.19	7.510
<i>Changchui District—</i>							
Sample A	..	0.63	3.13	77.05	10.10	1.00	7.977
Sample B	..	0.73	2.35	81.69	6.03	1.27	7.709
<i>Fangtze District—</i>							
Coal from west pit	..	5.50	9.00	59.39	16.11	0.49	6.870
Coal from east pit	..	4.20	13.60	69.00	12.20	0.54	4.434
Coal from south pit	..	5.00	11.00	58.94	16.60	0.65	6.415

—Chinese Economic Bulletin.

# State Plants for Industrial Development in China\*

## The Steelworks Project

HERE is no denying the fact that China has lagged in industrial progress. Many facts can be cited to show the inability of the Chinese to compete with Europeans and Americans in the efficiency and technique of manufacturing industry, and none is so strong as the huge unfavorable trade balance which China incurs every year. The larger this adverse balance, the clearer the indication of China's need of some speedy means of industrial development, so that she may be in a better position to supply herself with commodities, which at present have to be obtained abroad.

The industrial era has a history of about 60 years in China, but so far has been subject to very slow evolution on a very unsound basis. It is with a view to preparing more fruitful ground for the future development of the nation's industry that the Ministry of Industry has formulated the Four-Year Industrial Plan whereby the Yangtze Valley will be made a model industrial center for the Government's program of national reconstruction. It is proposed to establish factories of primary importance, including a central machine shop, paper-mill, iron and steelworks, and factories producing ammonium sulphate, woollen goods, porcelain, sugar, and rayon.

Those who are not aware of the unremitting exertions made by the Ministry of Industry during the past two years toward the materialization of this Industrial Plan are apt to think that the scheme is much too big to be put into operation, while other critics even go so far as to say that the Plan will never become anything more than a blueprint of a castle in the air. Such critics fail to realize the fact that before anything can be done in the way of building factories and the purchase of machinery, a great deal of patient and expert investigation is needed in regard to the choice of suitable sites, supplies of raw material, and problems concerning equipment, because hasty action in the establishment of such enterprise inevitably leads to blunders which involve waste of time, money, and effort. And in a country like China, where the science of statistics is yet in the elementary stage, and information of a reliable character is not easy to get, the time and labor which has to be spent in preliminary investigation is far beyond what a layman might expect.

In the present series of articles an effort will be made to reply to the many unwarranted criticisms directed against the Ministry for tardiness in carrying out its proposed plan. Since among the industrial enterprises to be established by the Ministry the ironworks, paper-mill, woollen factory, and porcelain works have been given less publicity than the other undertakings proposed, they will be dealt with exclusively in turn.

### State Steelworks

Generous production of iron and steel is of essential importance to the development of China's industries, and an important factor also in the development of the country's communications. With other reconstruction projects still to be started, the extension of railways alone demonstrates the necessity of China having her own iron and steel plants.

With the exception of the Yangtze Engineering Works, the Hankow and Yangchuen Smelting Works, Shansi, and a few small Bessemer furnaces in Taiyuan and Szechuen, the iron and steel plants established in China have been suspended owing to various difficulties. Consequently, the present output of iron from Chinese furnaces amounts to less than 100,000 tons annually, while that of steel is scarcely half that amount. This is far from being adequate to meet the huge demand, which increases every year in proportion to the rapidity with which industry has developed since the establishment of the present National Government. Every year millions of dollars worth of iron and steel has to be brought into China from abroad.

It was with a view to checking any further increase in China's iron and steel imports that the Ministry of Industry, in accordance with Dr. Sun's Plan in connection with the utilization of foreign capital for the development of the nation's industry, negotiated with the German firm of Gutehoffnungshütte, of Oberhausen, for the construction of a state iron and steelworks. Since signing that

contract the Ministry has been seeking a suitable site, studying the quantity and quality of raw materials likely to be obtained in various localities, and drafting a detailed plan for the establishment of this great undertaking.

The Sino-German agreement signed on January 26, 1932, and approved by the Executive Yuan, consisted of ten clauses, of which the more important were as follows:

- (1) Advance of a loan of between sixteen and twenty million gold dollars.
- (2) The Chinese Government to issue bonds to the above amount at seven per cent annual interest.
- (3) The bonds to be held by the German interests as security.
- (4) China to repay the principal by instalments.
- (5) The Chinese Government to send representatives to Germany to study the iron and steel industry and supervise the purchase of machinery and materials from that country.

To facilitate execution of the project, a committee of about a dozen experts was appointed by the Ministry of Industry, who started work in March, 1932. Accompanied by representatives of the German interests, this committee made an extensive investigation of the coal reserves at Huaihsien, the iron deposits at Fancheng and Tangtu, and limestone and dolomite beds at Pukou.

### Two Suitable Sites

With reference to the choice of a site, the ideal position for a steelworks is obviously in the immediate proximity of iron and coal reserves. While such places exist in the Three Eastern Provinces, they are not found in other provinces, as the iron deposits lie mostly north of the Yangtze, and coal is found generally south of the river. From the point of view of communication facilities, Pukou appeared to be a suitable site, but was found rather too accessible and therefore objectionable from the strategic viewpoint. As for the other suggested sites, Ma-an Shan (Saddle Mountain) and Hsiehchiatien are both suitable, though the former seems more likely to be chosen.

Ma-an Shan, two kilometers from Tangtu, Anhui Province, is south of the Yangtze. Land in this district is generally below the river level, and the whole area was inundated in 1931 during the great flood. However, there are sites on slopes which are from 10 to 20 feet above the Yangtze, making an ideal site for an enterprise of this kind. In the vicinity are a number of small streams in addition to a large pond, from which the foundry could obtain an adequate water supply. The Saddle Mountain itself offers very good protection to the works, and a little more than 10 kilometers to the south is the Tangtu iron-mine, thus solving part of the raw material problem. As to transportation facilities, in addition to the existing equipment belonging to the I Hua Company including a wharf and a narrow-gauge railway from the iron-mine to the wharf, the steelworks could build a wharf of its own near that of the I Hua, and a standard gauge railway connecting the wharf with the factory. The fact that the proposed site is very close to the Nanking-Wuhu Highway at a point where the proposed Nanking-Hunan Railway will pass, would facilitate the transportation of factory products to distant markets. Moreover, the site is only about 50 kilometers by water from Pukou, which renders the transport of coal supplies fairly easy. Coal brought from the north by the Tientsin-Pukou Railway could be quickly transhipped to the steelworks from Pukou, and supplies from Pinghsiang, carried from Wuchang (via Yushan-Pinghsiang and Hunan-Hupeh Railway) or Kiukiang (via Yushan-Pinghsiang and Nanchang-Kiukiang Railway) would be available by water.

The other possible site for the steelworks, Hsiehchiatien, lies in the district of Luho on the northern bank of the Yangtze, and is 20 kilometers from Pukou. The land between Pukou and Hsiehchiatien is very low, but the proposed site is surrounded by hills, and thus secure from the danger of being flooded. A new wharf, and a railway linking the wharf with the works, would have to be built. Coal could be brought by the Tientsin-Pukou

\*The Chinese Economic Journal

Railway to Pukou, which is not far from the site, or, when financial conditions permit, a short railway from Puchen to the steelworks could be constructed expressly for coal transport. Coal from Pinghsiang can be brought to Hsiehchiatien in exactly the same way as to Ma-an Shan. As for iron-ore supplies, a sufficient quantity is obtainable from Tangtu.

On the whole, however, Ma-an Shan is considered a better site than Hsiehchiatien, and is therefore more likely to be selected. Geologically, the former has a definite advantage over the latter place, where the ground is less solid.

Supplies of Raw Materials

Iron, coal, manganese, limestone, and dolomite are the principal raw materials needed for manufacturing iron and steel, and experts have been sent out by the Ministry of Industry to various places to locate the most suitable sources of supply. The following particulars represent the result of long and careful research :

*Iron-ore.*—The most convenient source is Tangtu, any deficiency to be brought from Hsiangpishan, Tayeh.

*Bituminous coal.*—The Leichiakou Colliery, Anhui, was at first suggested as a suitable source, but an analysis made in February, 1934, showed that the coal was unsuitable. It is said that supplies from the Kaokeng Colliery, Pinghsiang, and the Chunghsing Colliery, Shantung, will prove much more suited to the purpose. In making steel, in addition to the gas provided by coke-ovens and blast-furnaces, a small quantity of bituminous coal has also to be used, and it has been found that the supply from the Hsunkengshan Colliery south of Huai River, will meet requirements. Experiments were made in mixing coal from this mine with that from the Chung-hsing Colliery to make coke and the results so far obtained have been quite satisfactory.

*Manganese.*—This will be brought mainly from Hsiangtan, Hunan Province, and Loping, Kiangsi Province.

*Limestone*—can be obtained either from Pukou or Tangtu.

*Dolomite*—is available from Pukou or Tayeh.

Supplies of Iron-ore

Details of the analysis, estimated deposits, cost of working and plans for transportation, etc., are as follows :

*Tangtu Mine.*—The iron deposits of Tangtu may be divided into two groups—those in the north-eastern and south-western districts.

NORTH-EASTERN MINES					
Location				Tons	Operated by
Nanshan	..	..	..	2,000,000	Li Ming
Tawashan	..	..	..	1,500,000	Pao Hsing
SOUTH-WESTERN MINES					
Location				Tons	Operated by
Chungshan	..	..	..	3,000,000	Chenyeh
Hsiaokushan	..	..	..	1,700,000	„
Other places	..	..	..	500,000	
ANALYSIS OF ORE					
		Iron	Silica	Sulphur	Phosphorus
Nanshan	..	62.94%	5.29%	0.10%	0.15%
„	..	63.09%	6.66%	0.16%	0.11%
Tayaoshan	..	58.08%	8.48%	0.09%	0.45%
„	..	57.04%	8.38%	0.09%	0.54%
Chungshan	..	58.17%	14.91%	0.062%	0.466%
Hsiaokushan	..	52.20%	22.57%	0.04%	0.04%

COST PER TON					
Delivered at Ma-an Shan site					
North-eastern mines	..	..	..	..	\$1.60
Mining expenses	..	..	..	..	\$0.90
Freight	..	..	..	..	0.70
South-western mines	..	..	..	..	\$2.10
Mining expenses	..	..	..	..	\$0.90
Freight	..	..	..	..	1.20
Delivered at the Hsiehchiatien site					
North-eastern mines	..	..	..	..	\$2.62
Cost at Ma-an Shan riverside	..	..	..	..	\$1.65
Freight from Ma-an Shan to Hsiehchiatien riverside	..	..	..	..	0.85
Freight to steelworks	..	..	..	..	0.12
South-western mines	..	..	..	..	\$2.30
Cost at Tsingshan	..	..	..	..	\$1.08
Freight from Tsingshan to Hsiehchiatien riverside	..	..	..	..	1.10
Freight from Hsiehchiatien riverside to steelworks	..	..	..	..	0.12

*Transportation.*—Since the mines are fairly close to the suggested sites, steam-tugs will serve as means of transportation. It has been suggested that two tugs and six 300 ton lighters will be sufficient to carry ore.

*Hsiangpishan Iron-mine.*—The Tayeh deposits are located chiefly north-east of the city. At Siangpishan there are large deposits, though smaller than the Tiehmenkan and Shihtsushan mines of the Hanyehping Company. The deposits extend for more than a kilometer, and have been worked since 1920 under the auspices of the Provincial Mining Bureau. A railway connecting the mine with the Yangtze wharf has been constructed. According to a reliable estimate, the total reserve amounts to approximately 13,000,000 tons, of which about 15 per cent is not suitable for smelting.

ANALYSIS OF ORE					
<i>Iron</i>	<i>Silica</i>	<i>Sulphur</i>	<i>Phosphorus</i>		
65.40%	3.18%	0.08%	0.05%		
COST PER TON					
Delivered at the Ma-an Shan site .. .. . \$2.90					
Mining expenses .. .. .	..	..	..	..	\$0.90
Railway freight from mine to Tayeh riverside ..	..	..	..	..	0.50
Loading expenses .. .. .	..	..	..	..	0.10
Freight to Ma-an Shan riverside .. .. .	..	..	..	..	1.15
Unloading expenses .. .. .	..	..	..	..	0.05
Freight to steelworks .. .. .	..	..	..	..	0.20
Delivered at the Hsiehchiatien site .. .. . \$2.97					
Mining expenses .. .. .	..	..	..	..	\$0.90
Railway freight from the mine to Tayeh riverside ..	..	..	..	..	0.50
Loading expenses .. .. .	..	..	..	..	0.10
Freight to Hsiehchiatien wharf .. .. .	..	..	..	..	1.30
Unloading expenses .. .. .	..	..	..	..	0.05
Freight to steelworks .. .. .	..	..	..	..	0.12

*Transportation.*—Boats are available for hire to carry iron-ore from Hsiangpishan to Ma-an Shan or Hsiehchiatien, but it would be much more economical for the steelworks to buy steam launches which, including the time necessary for loading and unloading lighters, would be able to ply between Tayeh and the steelworks three times a month. With two steam launches capable of towing 2,500 tons in lighters, about 150,000 tons of ore could be handled a month and transportation by the steelworks' own boats would reduce the freight to less than \$1 per ton.

No doubt, during the first few years of operation, it would be better to bring ore from Tangtu instead of Hsiangpishan, the former being nearer the proposed sites, but the fact that limestone, dolomite, etc., have to be brought from other places makes the steam launches necessary all the same.

Iron deposits occur in many places in Kiangsu and Anhui other than Tangtu, and for reference the following table giving brief details of the various available deposits in these two provinces is appended:—

Location		Tons	Percentage of Iron Content	Distance from	
				Ma-an Shan	Hsiehchiatien
Kiangning	.. Feng-Huang Shan, 60 li south of the city of Nanking.	4,000,000	49.00-52.00	35 km. by land to Nanking and 50 km. by water from thence to Ma-an Shan.	35 km. to Nanking and 28 km. by water from Nanking to Hsiehchiatien.
Tungshan	.. Lichiawan Shan, Tieh Shan, Hsima Shan, Tungma Shan, Chiuchia Shan, Nanma Shan, Yang Shan, Kangshantao and Tung Shan	3,000,000	65.24-54.93	375 km. to Pukou and 50 km. thence to Ma-an Shan by water.	375 km. to Pukou and 20 km. from Pukou to Hsiehchiatien by water.
Fanchang	.. Taochung, 40 li north-west of the city, and Tatung Shan and Hsiao-tung Shan in the eastern Suburb.	8,000,000	56.37-70.00	9 km. to Tikang by railway and 120 km. from Tikang to Ma-an Shan by water.	170 km. from Tikang by water.
Tungling	.. Tungkuan Shan, 11 km. south-west of the city.	3,000,000	68.76-69.85	15 km. by land to Tatung and 175 km. by water from Tatung to Ma-an Shan.	245 km. by water from Tatung.

## Bituminous Coal

**Kaokeng Colliery.**—This represents part of the coal reserves at Pinghsiang, the quality being especially suitable for making coke. It was formerly worked by small concern, and the Hanyeh-ping Company once made an attempt to operate the mine. The Ministry of Industry, with the approval of the Executive Yuan, is planning to bring it under State ownership. It is estimated that the reserve amounts to approximately 100,000,000 tons.

### ANALYSIS

Seam	Shaft	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.
4	Sanchia	1.10	26.50	60.30	3.10	0.73	13,700
7	Peng	1.40	29.20	61.30	8.10	0.64	14,300
8	Ta	1.00	24.40	65.70	8.90	0.23	14,300
10	Falai	1.20	30.90	60.30	7.60	0.88	14,300
13	Maku	1.10	28.00	61.60	9.30	0.52	14,100

### COST PER TON

Cost at pithead	..	..	..	..	..	..	\$3.50
Cost of mining	..	..	..	..	..	..	\$2.00
Power generation and repair to equipment, etc.	..	..	..	..	..	..	0.90
Administrative and other miscellaneous expenses	..	..	..	..	..	..	0.60
Freight from Kaokeng to Wuchang	..	..	..	..	..	..	3.28
Railway charges	..	..	..	..	..	..	3.10
Loading and unloading expenses	..	..	..	..	..	..	0.18
Freight from Wuchang to Ma-an Shan	..	..	..	..	..	..	1.55
Loading expenses at Wuchang	..	..	..	..	..	..	0.10
Boat freight from Wuchang to Ma-an Shan	..	..	..	..	..	..	1.20
Unloading expenses	..	..	..	..	..	..	0.05
Transportation from Ma-an Shan riverside to steelworks	..	..	..	..	..	..	0.20
Freight from Wuchang to Hsiehchiatien	..	..	..	..	..	..	1.57
Loading expenses at Wuchang	..	..	..	..	..	..	0.10
Boat freight from Wuchang to Hsiehchiatien	..	..	..	..	..	..	1.30
Unloading expenses	..	..	..	..	..	..	0.05
Transportation from Hsiehchiatien riverside to steelworks	..	..	..	..	..	..	0.12

Kiukiang is as good a transshipping centre as Wuchang, especially when the proposed Yushan-Pinghsiang railway is completed, by which coal can be transported from Kaokeng to Nanchang, capital of Kiangsi, thence to Kiukiang via the Nanchang-Kiukiang railway. The approximate cost of transportation by this route per ton from Kaokeng to the suggested sites at Ma-an Shan and Hsiehchiatien is estimated as follows:—

Freight from Kaokeng to Kiukiang	..	..	..	..	..	..	\$2.34
Railway freight	..	..	..	..	..	..	2.16
Loading and unloading expenses	..	..	..	..	..	..	0.18
Freight from Kiukiang to Ma-an Shan	..	..	..	..	..	..	1.40
Loading expenses at Kiukiang	..	..	..	..	..	..	0.10
Boat freight from Kiukiang to Ma-an Shan	..	..	..	..	..	..	1.05
Unloading expenses at Ma-an Shan riverside	..	..	..	..	..	..	0.05
Transportation from Ma-an Shan riverside to steelworks	..	..	..	..	..	..	0.20
Freight from Kiukiang to Hsiehchiatien	..	..	..	..	..	..	1.42
Loading expenses at Kiukiang	..	..	..	..	..	..	0.10
Boat freight from Kiukiang to Hsiehchiatien	..	..	..	..	..	..	1.15
Unloading expenses	..	..	..	..	..	..	0.05
Transportation from Hsiehchiatien riverside to steelworks	..	..	..	..	..	..	0.12

**Transportation.**—The Kaokeng colliery is about 12 kilometers from the well-known Pinghsiang mine, and therefore its output can be carried to other provinces by the same route as Pinghsiang coal, which used to center at Wuchang for re-shipment. Wuchang is an ideal port for transshipping because it is easily accessible by land and water, and is a place where the Yangtze is comparatively broad and deep, and navigable throughout the year by ships of large tonnage.

Formerly Pinghsiang coal was often first brought to Hanyang by water and thence sent to Wuchang. The fact, however, that Tungting Lake is frequently too shallow for large craft causes considerable waste of time and money. Railway transportation is consequently preferred to water.

To facilitate the transport of Kaokeng coal, the Ministry of Industry has planned a railway 12 kilometers long to connect the colliery with the Chuchow-Pinghsiang Line at Pinghsiang, whence the coal can be easily carried to Wuchang, a distance of about 510 kilometers. Though at present the freight for coal on the Hankow-Canton Railway—of which the Chuchow-Pinghsiang is a section—is fixed at \$4.60 a ton, a much higher rate than that prevailing on the Tientsin-Pukou Railway, it is possible that the Ministry of Railways would reduce the freight on this line also.

An alternate route may be taken in sending Kaokeng coal to the proposed sites at Ma-an Shan and Hsiehchiatien, but this is possible only during spring, summer and autumn, which are high-water seasons on the Yangtze. The river is navigable by ships above 6,000 tons, and instead of using Wuchang, coal from Kaokeng may be conveyed to Yochow as a transshipping port, where boats are available to forward consignments either to Ma-an Shan or Hsiehchiatien. It is estimated that by thus taking advantage of the high-water level of the Yangtze, a saving of about 99 cents per ton could be easily effected in the cost of transportation, and assuming this was done for six months in the year, the amount saved will reach a quite substantial figure.

At present, coal from Wuchang can be conveyed to Ma-an Shan or Hsiehchiatien at about \$1.20 per ton by boats returning from carrying Kailan coal to Hankow, the freight being regulated on the assumption of Pukou being the destination. However, it is possible for the Kailan supply to be displaced from the Hankow market by the Kaokeng product, when the latter is produced in large volume through State operation of the mine, thus reducing the number of available boats in Hankow. It is therefore suggested that the steelworks buy two steam boats, each with a capacity of 3,000 tons, and with its own fleet it is expected that the cost of freight will decrease by from 20 to 30 cents a ton, on the basis of the following estimate:

Cost of ships	..	..	..	..	..	\$600,000
Overhead expenses per month	..	..	..	..	..	14,900
Fuel consumed on round trip	..	..	..	..	..	168 tons
Time required for round trip	..	..	..	..	..	171 hours

Assuming that the price of fuel \$12 per ton, and 6,000 tons of coal are loaded on the two ships each trip, then the cost of transporting coal from Wuchang to Ma-an Shan or Hsiehchiatien will amount to 92 cents per ton as against \$1.20, which is the freight charged by boats engaged in carrying Kailan coal to Hankow.

However, at the beginning of operations, the quantity of coal produced may not warrant the purchase of ships, and during the transitional period several vessels of light draught, together capable of carrying 6,000 tons, would be more serviceable. Assuming that it takes 10 days to make the round trip between Wuchang to Ma-an Shan (or Hsiehchiatien), the hire of the boats at \$375 a day and consumption of 176 tons of bunkers at \$12 per ton would bring the cost of transporting coal to approximately 98 cents per ton, which is still a favorable rate.

**Chunghsing Colliery.**—This mine is at Tsaochuang, Shantung Province. The local is good for making coke, but not so pure as that from Kaokeng, owing to the comparatively high ash percentage. The mine is operated by the Chunghsing Mining Company, and the total deposit is estimated at 100,000,000 tons.

Tsaochuang is connected with Pukou by the Tientsin-Pukou railway, and the cost of transportation from the mine to Pukou per ton amounts to \$2.634, calculated on the special freight rate granted by the railway to the Chunghsing company.

### ANALYSIS

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.
Washed coal	..	0.40	31.75	61.05	6.80	—
Coal dust	..	0.72	32.66	53.43	13.19	1.10
Unwashed coal	..	0.24	30.82	58.76	10.18	0.95

### Cost Per Ton

Chunghsing coal costs \$4 per ton at the pithead, and railway freight and expenses incurred in loading and unloading brings the cost at Pukou to about \$7 per ton, while the selling price is about \$9. However, it is believed that the Chunghsing Company would be able to offer the steelworks a special reduction of a dollar per ton off the usual price. Thus, at Ma-an Shan and Hsiehchiatien the cost per ton of Chunghsing coal would be about \$8.75 and \$8.52 respectively, taking 75 cents as the cost of transportation from Pukou to the former place and 52 cents to the latter.

**Transportation.**—To transport coal from Pukou to Ma-an Shan (or Hsiehchiatien), the Ministry of Industry plans to buy six lighters of 300 tons each, and two small steam launches. The same boats could be used to carry limestone and mica.

**Liechiakou Coal Field.**—This is located at Shuhsien, Anhui, 26 kilometers from Fulichi on the Tientsin-Pukou Railway (278.7 kilometers from Pukou). It has never been worked, though the

Lishan Mining Company holds the right of operation. The reserve is said to be large, and if operated exclusively by the Ministry of Industry, would be more than enough for the requirements of the steelworks. According to investigations made some fifteen years ago, the deposit consists of two seams, measuring about 20 feet at the thickest part. To obtain further details, the Ministry last spring made a contract with the German firm of Gutehoffuenschuttle for prospecting the deposit. Work was accordingly started in April, and so far two places have been drilled. It is reported that the seams are thick and the deposits very rich, but the high ash percentage and insufficient volatile matter do not meet the purpose in making coke for steel-making, unless mixed with some other variety of coal. The following are further particulars of this field :—

*Deposit.*—The total coal reserve at Leichiakou is estimated at 30,000,000 tons. The result of the first investigation made some 15 years ago was as follows :

Drilling	Depth	Coal Discovered	Depth	Coal Discovered	Depth	Coal Discovered
3rd ..	232'	6'	457'	8'	557'	26'
" ..	597'	1'	622'	1'2"	644'	5'
4th ..	353'	2'5"	440'	10'	458'	2'
" ..	751'	2'5"	762'	25'	—	—
6th. ..	303'	3'6"	490'	15'	810'	8'6"
7th. ..	398'	5'	610'	2'	615'	2'
9th. ..	270'	20'	559'	2'	567'	3'
" ..	643'	7'	658'	1'	—	—
10th. ..	657'	2'	679'	2'	770'	17'
" ..	104'	20'	—	—	—	—
11th. ..	297'	3'	345'	8'	370'	1'
" ..	378'	1'	645'	10'	—	—
12th. ..	286'	2'	550'	10'	640'	10'

During recent drillings it was found that the seam was three feet thick at a point 251 feet underground, and 18 feet and 19½ feet thick respectively when drilled to a depth of 332 and 661 feet.

#### ANALYSIS

Seam	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.
2	0.70	17.60	58.40	23.30	0.46	—
3	0.92	17.63	63.08	18.37	—	12,493

#### Cost

At Ma-an Shan the cost per ton of Leichiakou coal would be about \$8.18 and at Hsiehchiatien, \$7.95, estimated on the following calculations :—

Cost at pithead .. .. .	\$3.40
Cost of mining .. .. .	2.00
Cost of power generation and repair of equipment, etc. ..	0.90
Administrative and other Miscellaneous expenses ..	0.50
Freight from the field to Pukou .. .. .	4.03
Cost of transportation to Fulichih .. .. .	0.80
Railway freight from Fulichih to Pukou .. .. .	3.05
Unloading expenses .. .. .	0.18
Cost of transportation from Pukou to Ma-an Shan ..	0.75
Cost of transportation from Pukou to Hsiehchiatien ..	0.52

*Hsunkengshan Colliery.*—This is also known as Huainan Colliery, located in Huaiyuan, Anhui Province. Coal from this mine contains a comparatively high percentage of volatile matter. Though it does not make good coke, it produces gas necessary in the process of making steel. According to a reliable estimate, the amount of this variety of coal consumed by the steelworks would not exceed 3,000 tons annually, and therefore it is planned that supplies will be obtained from the Huainan Mining Company :

#### ANALYSIS

Shaft	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Calories
No. 1 ..	2.49	37.32	51.61	8.58	0.90	70.29
No. 2 ..	1.75	37.93	51.70	8.62	0.85	70.83
No. 4 ..	2.91	36.46	52.88	7.75	0.68	72.52

#### Cost

The product of the Huainan Colliery used to be first carried to Pengpu by water, and thence to Pukou by the Tientsin-Pukou Railway. The current price at Pukou is about \$9 a ton, and with freight will make the cost at Ma-an Shan about \$9.75 per ton (or \$9.52 at Hsiehchiatien).

### Manganese

From five to six tons of manganese is mixed with every 100 tons of iron, so that if the annual output of iron amounts to 80,000 tons, the consumption of manganese will not exceed 5,000 tons. Apparently, it is not economical for the steelworks to operate mines exclusively for this small supply.

The best-known manganese mines in China are located in Hsiangtan and Changlai, Hunan Province, Loping, Kiangsi Province, and Yanghsin, Hupeh Province. Deposits at Changlai and Yanghsin were formerly worked by the Hanyehping Company, and those in the two other districts by the Yushen Company, but operations have long been suspended. It is expected that when the demand increases by the opening of the steelworks, the latter concern will resume working its mines.

#### Hsiangtan Deposits.

#### ANALYSIS

Manganese	Iron	Silica Oxide	Phosphorous
45-55%	5-6%	5-12%	0.10-0.40%

#### Cost

The ore has first to be carried to the nearest station on the Hunan-Hupeh section of the Canton-Hankow Railway, by which it is conveyed to Wuchang, so the cost of transport is only a little more than in shipping Kaokeng coal. The fact that it is more expensive to operate a manganese mine than a colliery also to the cost of production. Roughly speaking, the company should be able to deliver ore at the factory site for about \$20 a ton.

#### Loping Deposits.

#### ANALYSIS

Manganese	Iron	Silica Oxide	Phosphorus
44.89%	4.74%	10.00%	0.20%

#### Cost

The ore must be first shipped to Kiukiang or Hukou as a transshipping port, and should be delivered at the steelworks for about \$20 per ton.

### Limestone

It is estimated that the daily consumption of limestone by the steelworks will be approximately 180 tons during the first few years of operation. Very large deposits are found at Pukou, not far from the proposed sites. Limestone from Tangtu is also available, especially if the steelworks is established at Ma-an Shan.

#### Supplies from Kiangpu, Pukou.

#### ANALYSIS

Location	Silica Dioxide and Non-solvents	Ferric Oxide	Lead Oxide	Calcium Oxide	Magnesium Oxide
Hsipo Shan ..	0.27	Very little	Very little	49.81	3.17
Kaochumiao ..	1.76	Little	Little	51.51	Little
" ..	4.56	"	"	51.68	"
" ..	3.34	"	"	52.01	1.53
" ..	0.23	Very little	Very little	54.72	—

#### COST

Price at Ma-an Shan .. .. .	\$2.15
Quarrying expenses .. .. .	\$0.60
Freight from quarry to Pukou .. .. .	0.80
Loading expenses at Pukou .. .. .	0.10
Boat freight from Pukou to Ma-an Shan riverside ..	0.40
Unloading expenses .. .. .	0.05
Conveyance to steelworks .. .. .	0.20
Price at Hsiehchiatien .. .. .	\$1.92
Quarrying expenses .. .. .	0.60
Freight from quarry to Pukou .. .. .	0.80
Loading expenses at Pukou .. .. .	0.10
Boat freight from Pukou to Hsiehchiatien riverside ..	0.25
Unloading expenses .. .. .	0.05
Conveyance to steelworks .. .. .	0.12

### Transportation

It would be advisable for the steelworks to buy a vessel, capable of carrying 2,500 tons, to convey limestone and dolomite from Pukou to the factory.

## Supplies from Tangtu.

## ANALYSIS

Silica Dioxide and Non-solvents	Ferric Oxide	Lead Oxide	Calcium Oxide	Magnesium Oxide
4.00	Little	Little	49.00	2.00

## COST

Price at Ma-an Shan .. .. .	..	..	..	..	..	\$1.30
Quarrying expense .. .. .	..	..	..	..	..	\$0.60
Freight from quarry to steelworks .. .. .	..	..	..	..	..	0.70
Price at Hsiehchiatien .. .. .	..	..	..	..	..	2.32
Cost at Ma-an Shan riverside .. .. .	..	..	..	..	..	1.35
Boat freight from Ma-an Shan to Hsiehchiatien .. .. .	..	..	..	..	..	0.85
Conveyance to steelworks .. .. .	..	..	..	..	..	0.12

## Dolomite

This is used as a substitute for magnesite as a lining for Bessemer furnaces, owing to its fireproof qualities. Very good dolomite is obtainable at Pukou and at Lichiachuang, Tayeh.

## Dolomite from Pukou.

## ANALYSIS

Location	Silica Dioxide and Non-solvents	Ferric Oxide	Aluminium Oxide	Calcium Oxide	Magnesium Oxide
Paochuang (western area) ..	1.54	Little	Little	30.97	17.75
Paochuang (surrounding area) ..	2.87	..	..	30.49	20.74
Paiyunshan (western area) ..	1.02	—	—	31.48	20.19
Paiyunshan ..	2.58	Little	Little	30.90	19.98
Kuantimiao ..	3.95	—	—	30.13	19.59
Kuantimiao (south-ern area) ..	0.53	—	—	30.62	18.91

## COST

Price at Ma-an Shan .. .. .	..	..	..	..	..	\$2.25
Quarrying expenses .. .. .	..	..	..	..	..	\$1.00
Freight from quarry to Pukou .. .. .	..	..	..	..	..	0.80
Loading expenses at Pukou .. .. .	..	..	..	..	..	0.10
Boat freight from Pukou to Ma-an Shan riverside .. .. .	..	..	..	..	..	0.40
Unloading expenses .. .. .	..	..	..	..	..	0.50
Conveyance to steelworks .. .. .	..	..	..	..	..	0.20
Price at Hsiehchiatien .. .. .	..	..	..	..	..	\$2.23
Quarrying expenses .. .. .	..	..	..	..	..	\$1.00
Freight from quarry to Pukou .. .. .	..	..	..	..	..	0.80
Loading expenses at Pukou .. .. .	..	..	..	..	..	0.10
Boat freight from Pukou to Hsiehchiatien riverside .. .. .	..	..	..	..	..	0.25
Unloading expenses .. .. .	..	..	..	..	..	0.05
Conveyance to steelworks .. .. .	..	..	..	..	..	0.12

## Dolomite from Tayeh.

## ANALYSIS

Silica Dioxide and Non-solvents	Ferric Oxide	Lead Oxide	Calcium Oxide	Magnesium Oxide
1.70	Little	1.20	35.99	15.49

## COST

Price at Ma-an Shan .. .. .	..	..	..	..	..	\$3.00
Quarrying expenses .. .. .	..	..	..	..	..	\$1.00
Freight from quarry to Tayeh .. .. .	..	..	..	..	..	0.50
Loading expenses at Tayeh .. .. .	..	..	..	..	..	0.10
Boat freight from Tayeh to Ma-an Shan riverside .. .. .	..	..	..	..	..	1.15
Unloading expenses .. .. .	..	..	..	..	..	0.05
Conveyance to steelworks .. .. .	..	..	..	..	..	2.20
Price at Hsiehchiatien .. .. .	..	..	..	..	..	\$3.07
Quarrying expenses .. .. .	..	..	..	..	..	\$1.00
Freight from quarry to Tayeh .. .. .	..	..	..	..	..	0.50
Loading expenses at Tayeh .. .. .	..	..	..	..	..	0.10
Boat freight from Tayeh to Hsiehchiatien wharf .. .. .	..	..	..	..	..	1.30
Unloading expenses .. .. .	..	..	..	..	..	0.05
Conveyance to steelworks .. .. .	..	..	..	..	..	0.12

## Factory Plan

It was the original intention of the Ministry of Industry to operate three separate steelworks in North, Central and South China. The plant here described is the one to be first established, and will be known as the Central Iron and Steel Works. When completed it will be able to produce 150,000 tons of steel annually, but during the experimental stage only half the full equipment will be operated, with an annual output of 75,000 tons.

The Ministry plans, on beginning operation of the factory, to take over the Kaokeng Colliery, Pinghsiang, of which the daily

output of bituminous coal is now estimated at 2,000 tons. Detailed plans regarding supplies of iron-ore, limestone, and dolomite have been also carefully drawn up.

Seven plants in addition to the colliery will be operated during the experimental stage of operations, which, as mentioned above, will call for the completion of only half the proposed scheme. The seven plants are as follows:—

- (1) Smelting-works
- (2) Steel-plant
- (3) Rolling-mill
- (4) Machine-shop
- (5) Power-plant
- (6) Coke-plant
- (7) Plant for extraction of by-products.

Of course, in addition to these main sections there will be many supplementary divisions such as chemical and physical laboratories, repair-shops, water-supply equipment, loading and unloading facilities at the wharf, equipment for transmission of gas and electric power, etc., and a railway is to be built to facilitate transport operations.

**Smelting Plant.**—During the experimental period, the factory will be provided with a blast-furnace with a daily output of 250 tons of pig-iron. The loading capacity of the furnace will be 430 kilo, the height being 35 meters, and measuring 5.60 meters in diameter at its widest part and 4.20 meters across the throat. The bottom of the hearth will be covered with corrugated wrought-iron plates in which cold water pipes are embedded, while 352 sets of cold water tubes will protect the walls of the furnace from the effects of heat and chemical action. Other equipment will consist of eight tuyere pipes and eight wrought-iron pillars at the bottom and a steel platform at the top, with four gas exhausts directed downward and meeting at one point in two main pipes or down-comers, each with a diameter of 1.30 meters and provided with two safety-valves. The diameter of the tuyere pipes ranges from 0.80 to 1.40 meters, while that of the cold water pipes will be 0.25 meters. Both cold water and tuyere pipes connect with a main pipe at the bottom of the furnace, which will be charged from the top.

The type of hot-blast used in the plant will be that which has the highest degree of efficiency for the amount of gas consumed. Three stoves with a diameter of eight meters and a height of 20 meters are to be installed for the blast furnace, the blast passing through one, while the others are heating.

To clean the gas from the blast furnace, a device is planned which will purify 60,000 cubic meters of gas per hour. The gas will pass through a series of settling chambers, condensers, baffle-plates, and a Theisen centrifugal cylinder, the moisture being removed by other apparatus. Experiments already made show that the results from this process are highly satisfactory, there being only 0.02 gram of foreign matter remaining in a cubic meter of gas after treatment.

The gas will be then led to a storage-tank with a capacity of 20,000 cubic meters. From the tank radiate a number of pipes through which the gas is distributed to the hot-blast stoves, steel plant, rolling-mill, coke-oven, etc.

Other equipment needed for the smelting-plant is a railway, space for the storage of ore, limestone, etc., trunks, and other facilities for conveyance. Storage space must be large enough to provide room for several months' supply of ore, etc., and should be located next to the blast-furnace and as near as possible to the coke-plant. Ore will be carried by an elevator to a bin provided with a trap door at the bottom, which will be opened whenever the blast-furnace needs charging. The ore will then fall into the weighing car, by which it is conveyed to the skip pit, and to charge the furnace it will be only necessary to lift the ore in a skip by a hoist, to the mouth of the furnace.

**Steel-plant.**—The Martin basic process is to be used, the composition of the steel being from 80 to 85 per cent of iron and from 15 to 20 per cent of scrap-steel from the rolling-mill. The principal equipment for the plant will be a 100 ton mixer, the hearth being 12 meters long and 3.80 meters wide, and having a surface of 38 square meters. In addition, two 50 ton Martin furnaces, 15 meters long, four meters wide, and with a surface of 36 square meters are to be installed. It is by the mixer that molten iron from the blast-furnace has its silicon and phosphorus content removed. The purified metal is then poured into the Martin furnace, where it is mixed with the proper proportion of scrap-steel and limestone to form pure steel, and ladled into ingots of from 1 to 1.20 tons each.

The estimated capacity of the mixer is 200 tons and that of the two Martin furnaces about 300 tons. In the event of the latter being out of order, the mixer can be easily converted into a Talbot furnace to make, about 170 tons of steel a day and, composed of 95 per cent iron and 5 per cent scrap-steel. The fuel used will be mixed gas from the blast-furnace and coke-oven, in addition to that from two Wellman gas-producers, consuming from 30 to 40 tons of coal a day.

To refine the steel, an electric furnace of two ton capacity and a diameter of 2.50 meters will be installed, capable on an average of handling from three to six charges every 24 hours. The electric arc, which produces heat for steel-refining, is between the electrode and the level of the steel charge in the furnace.

Other important equipment in connection with the steel-plant include a dolomite kiln, a limestone kiln, a manganese-melting furnace, a cast-steel annealing furnace, and a machine to remove steel ingots from the moulds. The fuel needed by the kilns will be chiefly supplied by the coke-oven in the form of gas.

*Rolling-mill.*—This will be divided into three parts according to the class of material handled—heavy, medium and light. Rails and large-size constructional steel are included in the first class. The machinery will consist mainly of two sets of three rollers, the first set having a diameter of 700 mm., intended for rough rolling. The second set does the finishing work, the rollers being 750 mm. in diameter, both sets being driven by a 200 h.p. 3-phase motor. Shells of a diameter of from 70 to 200 mm., 43-kilogram rails, I-beams, and steel blocks of various shapes are to be the main output.

In the medium class, three sets of three rollers are the principal equipment, the diameter of the rollers being 450 mm. The motive power is to be generated by an 800 h.p. 3-phase motor. The principal products in this class will consist of steel bars with a diameter of from 25 to 35 mm., tubes of 35 mm. diameter, angles, joists, fishplates, etc.

Steel wire for use in ferro-concrete work, small steel rods and bars, etc., represent the light class of products. The workshop is to be furnished with five sets of three rollers, the diameter of the rollers ranging from 250 to 280 mm. The motor to be used will be the same as that in the medium class.

There will be no bloomery during the experimental period of operation, as no heavy ingots are to be made, and the heavy section of the rolling-mill will serve as a substitute for a bloomery.

Two other furnaces will be needed—one to dry steel ingots or casting for the heavy-steel workshop, and the other to handle those for the medium and light steel shops. The large furnace will have a heating surface of  $20 \times 3.30$  meters and is provided with iron rails, accommodating two rows of ingots or castings, which are pushed into the furnace from one side and come out on the other after being dried by passing over 17 gas-burners. A furnace such as this will easily dry 20 tons of steel per hour.

The small furnace is exactly of the same type, but with only seven gas-burners and a smaller heating surface ( $6 \times 1.20$  meters).

*Machine-shop.*—This will consist principally of a repair-shop, pattern-making shop, foundry, riveting shop, and nail-shop.

*Power Plant.*—The power plant will include a boiler-room, motor-room, and auxiliary gear.

There will be four boiler units, one being held in reserve. The pressure of each boiler will be 29 atmospheres, while the degree of super-heating ranges from 375 to 400 C. with a heating surface of 400 square meters. The following are the features of each boiler unit:

Feed-water temperature	..	..	..	40°C.
Water from economiser	..	..	..	150°C.
Steam pressure	..	..	..	29 atmospheres
Degree of super-heating	..	..	..	375°-400°C.

The steam-producing capacity of a boiler varies with the fuel used. Thus, when gas from the blast-furnace is employed, it is about 12,000 kilograms per hour under normal conditions, and 14,000 at highest pressure. When coke-ovens supply the gas, the normal capacity is 14,000 kilograms, and the highest, 18,000.

The boilers will get feed-water from three centrifugal pumps, two driven by steam and one by electricity, each pump supplying enough for three boiler units.

Blowers used in connection with the blast-furnace and electric-motors are to be driven by steam turbines.

*Coke Plant.*—Otto Hoffmann ovens are to be installed, and there will be 25 to start with, the dimensions of each

	Meters
Length	12.670
Height	4.000
Average width	0.450
Distance between axes of two ovens	1.100

Either rich or inferior gas may be employed as fuel for Otto ovens, and the daily output of coke aggregates about 350 tons.

The gas produced by the ovens is a valuable by-product, and will be stored in a tank, from which it will be distributed to various plants of the factory.

In order to reduce the ash content of coke, coal has to be washed after entering the factory, and for this purpose, it is planned to install a coal-dressing plant adjacent to the coke-ovens.

*Mill for Extraction of By-products.*—At the beginning of operations, the mill will consume about 400 tons of dry coal a day. However, the gas-main installed in the plant should be large enough to provide for the passage of gas for burning 800 tons of coal.

The procedure of extraction is simple, consisting of carrying the gas from coke-ovens to cooling-towers, thence forced by centrifugal pumps to a final cooling-tower, an ammonia-absorbing tower, a benzol-absorbing tower, and finally to a gas-tank.

There are at least four valuable by-products obtainable by these processes,—gas, ammonia, benzol, and naphthalene, in addition to many other products in small quantities, such as antheracepe, pitch, etc. It is planned to have several special sections for extracting ammonia, benzol and naphthalene.

## Mica Mining in Ceylon

That there are widespread deposits of mica in Ceylon which are capable of lucrative commercial development if facilities for mining are extended by the Government is the opinion of Mr. R. Janaki Ram, a mica expert with many years of experience in India and other parts of the world. Mr. Ram is in Ceylon at present endeavoring to establish a local mica mining industry on a large scale. He has already prospected in various parts of the Island and is pressing on the Government for adequate facilities to begin work.

"I am of opinion that this Island has rich deposits of mica scattered over the country," he told the *Times of Ceylon* on Thursday, "and the mineral is mostly of the pheogophite variety in the mid and up-country while the south is smeared with traces of muscovite mica of the first order, capable of yielding enormous quantities, the quality being far superior to that of the Bolivian or Bengal varieties. Ceylon mica can, I am sure, command a ready market.

"This is especially important to Ceylon to-day in this age of electricity, when the demand is increasing rapidly in connexion with electrical construction work, as an insulating medium as also in various other directions.

"Although I see the prospects in this Island are very promising, there are a good many difficulties in the way of bringing the industry

into being, and if these difficulties are to be surmounted the Government must extend opportunities. At present I find that there is no Ordinance governing mica mining. In India and other mica mining countries like Canada, Rhodesia, Madagascar and Bolivia, there are certain fixed regulations governing the industry, and in return for this the Government gets its recompense in the way of royalties, land rent and income tax, as well as employment for large numbers of skilled and unskilled workers. In India there is a Government royalty of five per cent. on the net output of a mine, and such a levy is dependent upon the square area of the mica slabs.

"In addition to everything else, there is adequate provision for the difficulties to be encountered in the early stages. At first a three years' lease of land is given, with option for renewal in case of success, or abandonment if the efforts are not promising. Thereafter too, if a mine is not worked, only a dead rent of Re. 1 per acre is charged, so that there is an undoubted advantage to the industry.

"Here in Ceylon there seems to be no conditions at all, and our application for a lease, while favoured by certain Government departments, was rejected on no expressed grounds, by the Executive Committee concerned."

# Water Supply in Hongkong

## The Story of a Triumph of Applied Science

By Professor C. A. MIDDLETON SMITH, M.Sc., M.I.Mech.E. (Dean of the Faculty of Engineering in the University of Hongkong)

### PART IV.—THE SECOND HARBOR PIPE LINE AND THE PROBLEM IN KOWLOON

**I**N the previous contributions of this series on the Water Supply of Hongkong, reference has been made to the (first) harbor pipe line carrying water from Kowloon to the island of Hongkong.

Recently a contract has been let by the Hongkong Government to the Hume Pipe Company for the second harbor pipe line. This will be laid toward the end of this year (1934). The first pipe line consisted of a steel pipe 12 inches in diameter, but the second pipe line will be 18 inches diameter and will be specially protected both on the inside and outside.

The shell of the pipe is made of steel  $\frac{7}{8}$  inch thick, tested to a hydraulic pressure of 500 lb. per square inch. After testing the pipe is wrapped round on the outside by a special coating, evolved by the contractors. It is claimed that this coating protects the steel shell from marine insects which usually bore through untreated steel.

The inside of the pipe is to have a concrete lining, half an inch thick. That lining is spun in the pipes as the latter rotate between lathe centers at a high velocity.

The contractors established works at Singapore some years ago. They have recently built a local factory on the Kowloon side of Hongkong, a few miles from the City of Kowloon, on the Castle Peak Road. They have purchased  $7\frac{1}{4}$  acres of ground, of which about half is on the sea front, the road roughly dividing the area.

It will be remembered that the first pipe line across the harbor was laid in the winter of 1929-30 and has proved a great success. Indeed, without the additional water supply given by it to the island the water shortage in the early months of 1934 would have been much more serious.

This second pipe line will be a great aid to the supply system of the island. But there will be no complete freedom from anxiety about water shortage until the Shing Mun Dam is able to add to the total storage capacity of the reservoirs of Hongkong.

It is difficult for the new-comer to Hongkong, who sees the large area covered by the new city of Kowloon, and who passes through some of the crowded thoroughfares—it is difficult for him to believe that until 1910 there was no public supply of water from reservoirs on that side of the harbor. And it is not easy for those of us who are old residents in Hongkong, and who have watched the mushroom growth of the new city, to realize how quickly it has developed, and spread over the peninsula.

The fact remains that it was until 1910 that what is known as the Kowloon reservoir, having a storage capacity of 352.5 million gallons, was completed. It is true that, in the report of the Director of Public Works for 1895, we find a note that there were "at Kowloon original waterworks to supply 250,000 gallons a day from three wells." In the report for 1902 we find the statement "new Kowloon waterworks commenced." Water from the wells was pumped into service tanks at different parts of Kowloon. But it soon



Fig 1.—Conduit diverting Shing Mun River to Kowloon Reservoir showing a typical catchment area for Kowloon water supply



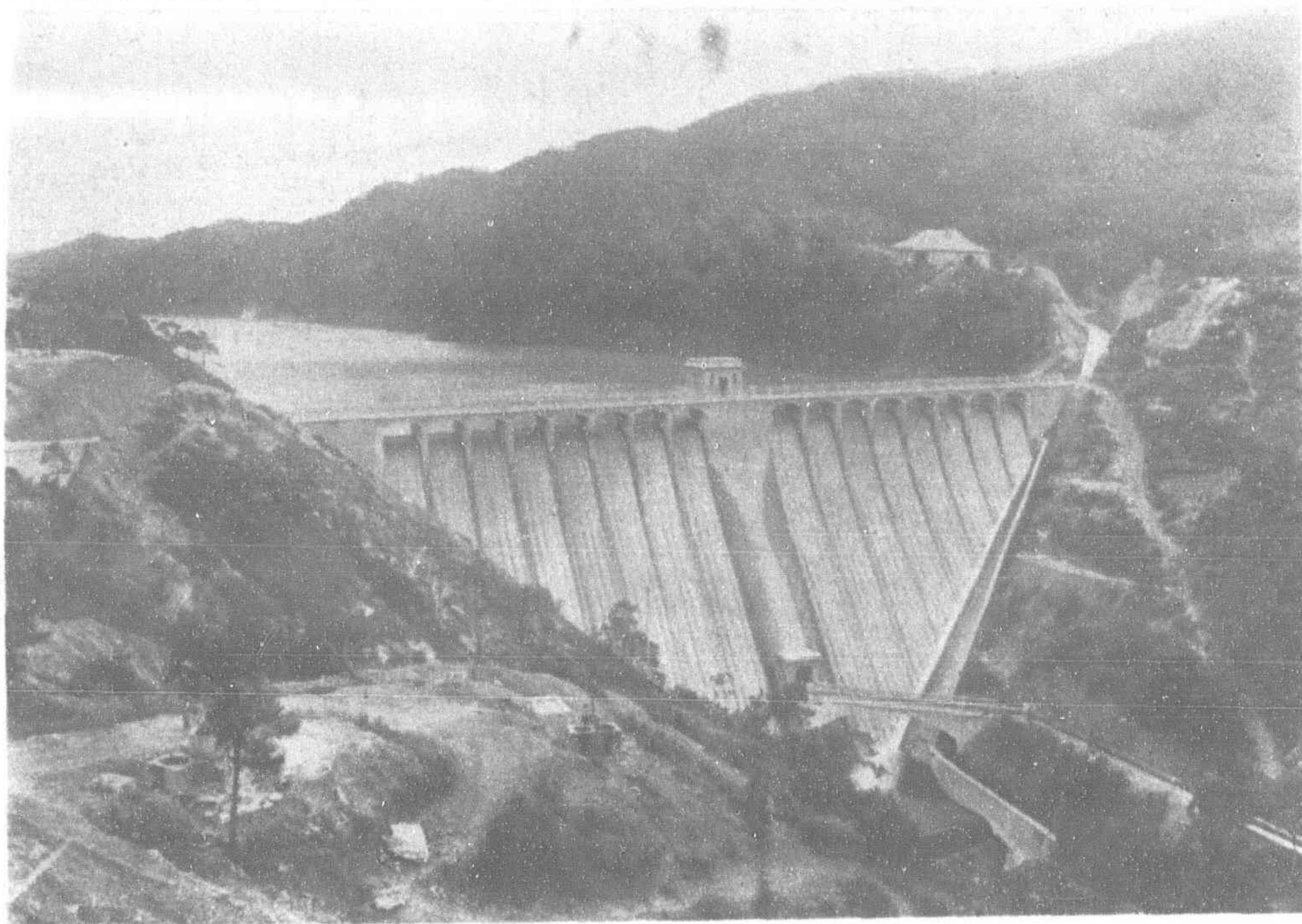


Fig. 3.—Kowloon Byewash Reservoir at Overflow



Fig. 4.—Commencing work on site for the Kowloon Byewash Dam

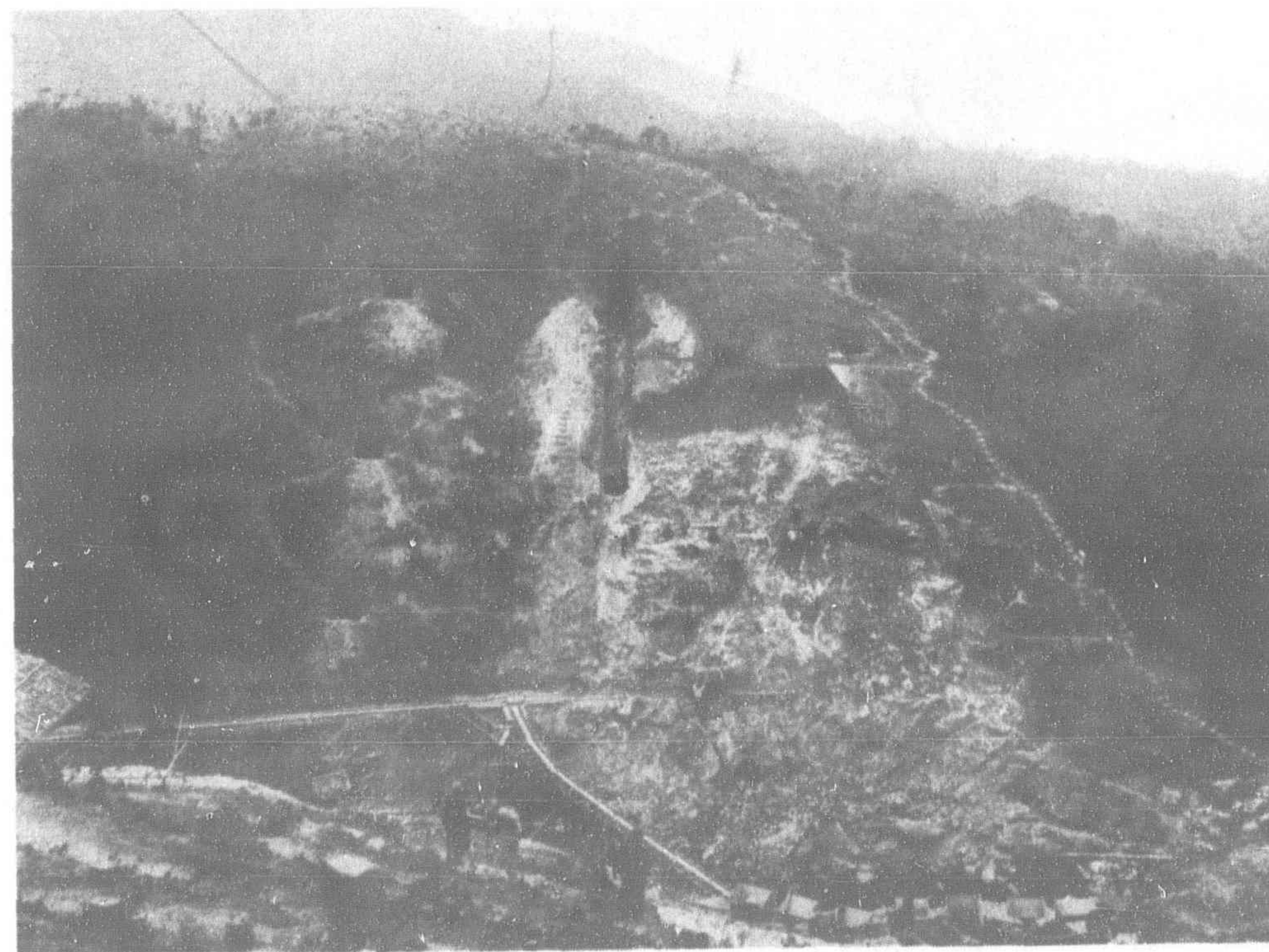


Fig. 5.—Making Trial Holes to determine site of Kowloon Byewash Dam

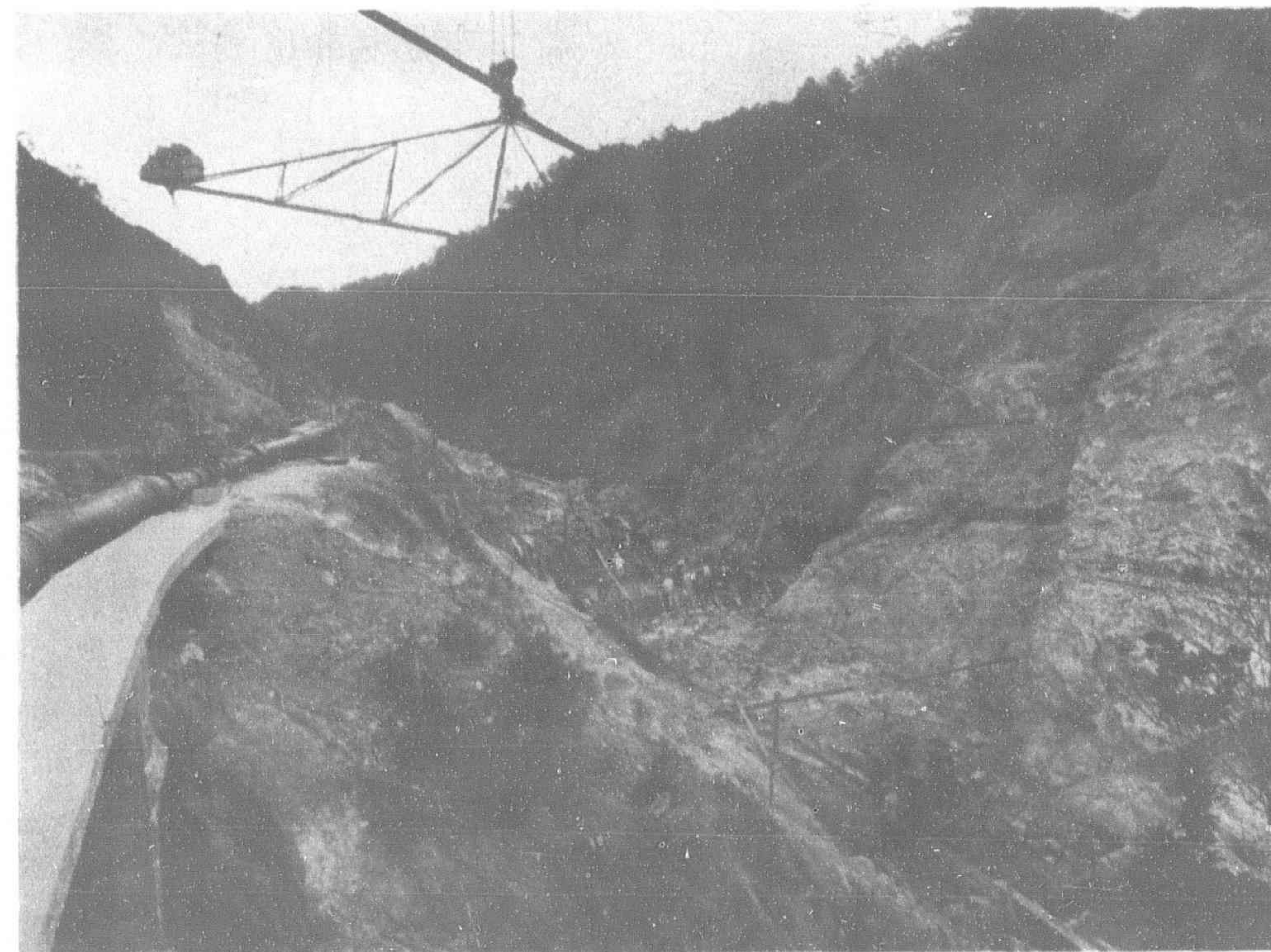


Fig. 6.—Initial stages of construction of Kowloon Byewash Dam

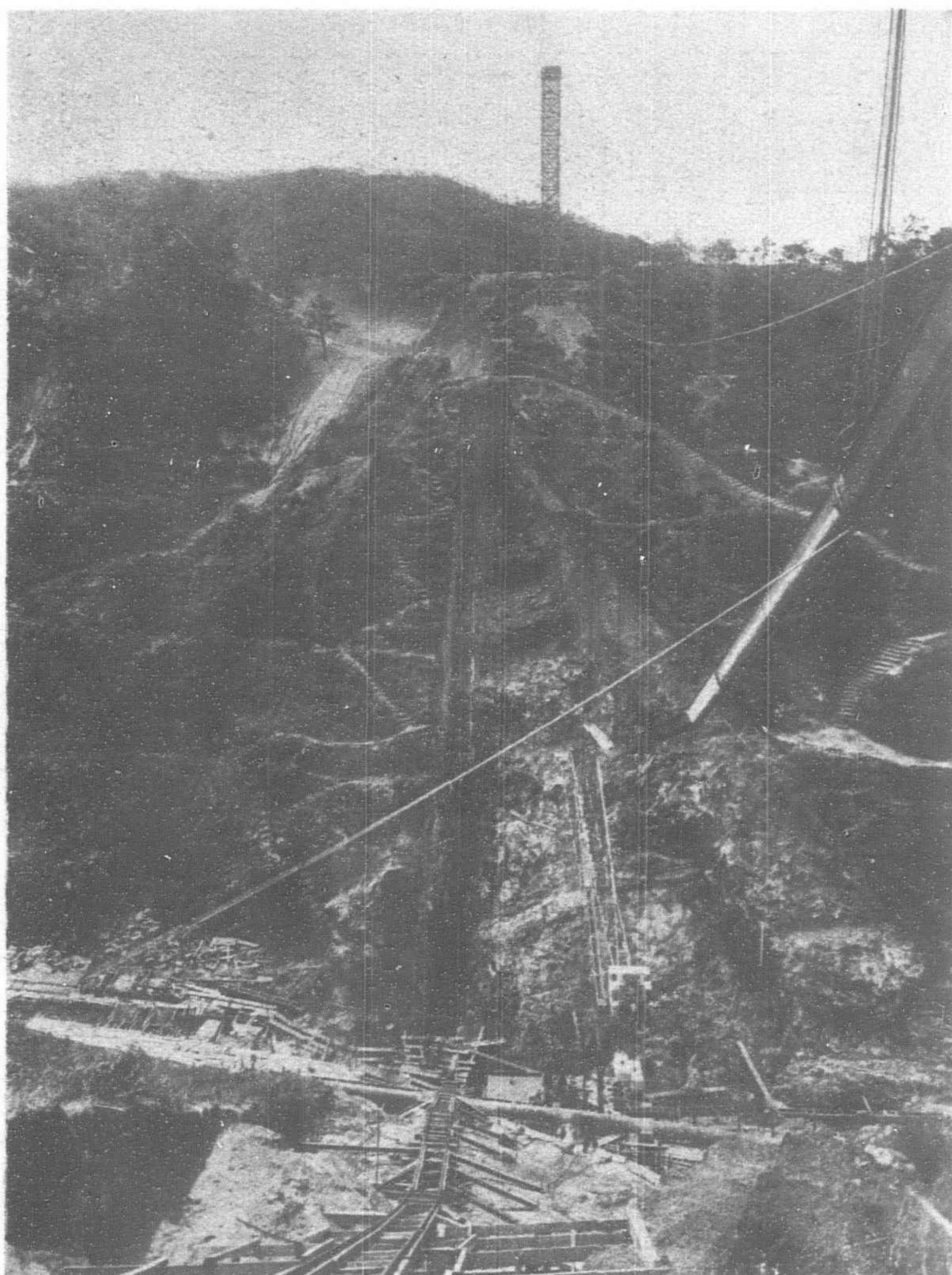


Fig. 7.—Transporters and Cranes used in construction of the Kowloon Byewash Dam



Fig. 8.—Scaffolding used in construction of Kowloon Byewash Dam

that, from 1899 onwards, considerable attention was given to the problem of supplying water to Kowloon.

It is worth noting that the engineer chiefly concerned with the first scheme for reservoir storage in Kowloon was a Mr. Gibbs, who came out to Hongkong in the service of the Public Works Department and who planned the original general scheme of water storage for Kowloon, a scheme which he subsequently carried out.

He, however, left the service of the Government and joined a local firm of Architects and Civil Engineers. And, as the Public Works Department of the Colony was understaffed when the local Government decided to build the first reservoir in Kowloon, that firm (Messrs. Denison, Ram and Gibbs), carried out the whole of the original scheme.

It is worth while remarking, in connection with the water supply for towns in China, a problem that is now engaging the attention of various Provincial Governments in China, that it is essential to obtain expert advice for the planning of such schemes. And careful supervision of the work as it is being carried out is important. Only engineers with experience of the class of work should have the responsibility of design and supervision.

Incidentally it may be remarked that Mr. Danby, who came out to Hongkong was Waterworks Engineer, and who built the tunnels near Tytam, was originally, in the service of the local Government. He resigned and commenced to practice as a Civil Engineer and Architect in Hongkong; and so did Mr. James Orange, who built the Tytam reservoir, and who became a partner of the well known local firm of Leigh and Orange, Architects and Civil Engineers. That firm has been responsible for many of the important Civil Engineering works in Hongkong carried out by private enterprise.

Of course the large area, and the non-productive nature of most of the soil, in the New Territories, as well as the comparatively high elevation of such a large proportion of it, makes the technical aspect of water collection and storage a comparatively simple matter.

The main feature of the scheme proposed by Mr. Gibbs was a storage reservoir in the hills behind Kowloon, and about five miles distant from that part of the peninsula nearest to Hongkong island.

An advantage of this scheme, and all those supplementary schemes for the supply of water to Kowloon, was that no pumping machinery is needed. The reservoirs are sufficiently elevated for the supply to be by gravitation.

It should be mentioned that during the whole of his career in Hongkong Mr. Gibbs constantly advocated a rapid extension of water storage. After he left the Public Works Department for private practice he frequently drew attention to the dangers of delay. But the fixed plan of paying for all new waterworks out of the revenue of the Colony, and the anxiety of the local Government to keep taxation low, led to a very short-sighted policy of continuous postponement of new storage capacity.

Fortunately the old arrangement of paying for non-recurrent works out of revenue was recently abandoned. The new schemes—including the Shing Mun Valley Supply from the New Territories—are financed by loans, which will be repaid out of the revenue which will result from the increased sale of water.

### The New Territories

In order that the reader may have some general idea of the lay-out of Kowloon city and its position, relative to the island of Hongkong and the New Territories behind the city, the map of the district has been sketched out (Fig. 2) for his guidance.

This map shows the position of the existing catchment areas (4,309 acres) the proposed extension of these areas (305 acres) and the possible extensions (6,645 acres). It also shows the existing storage reservoirs, those that are proposed, and those that are possible.

It makes obvious the route of the pipe line that connects the Kowloon storage system with Hongkong island so that a supplementary supply to the island is now available. It shows only one



Fig. 9.—The Kowloon Byewash Dam nearing completion

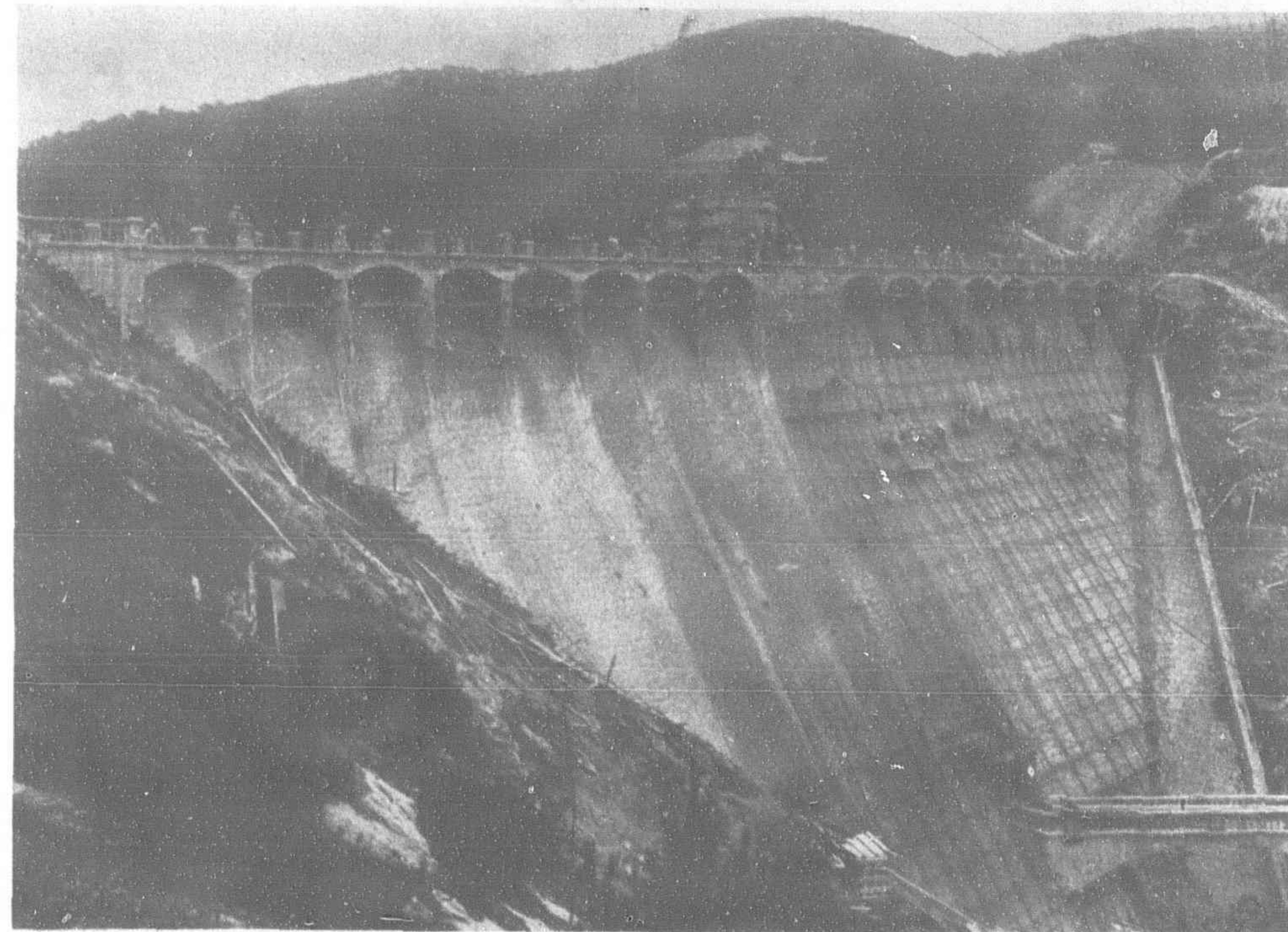


Fig. 10.—Cleaning downstream Face of the Kowloon Byewash Dam

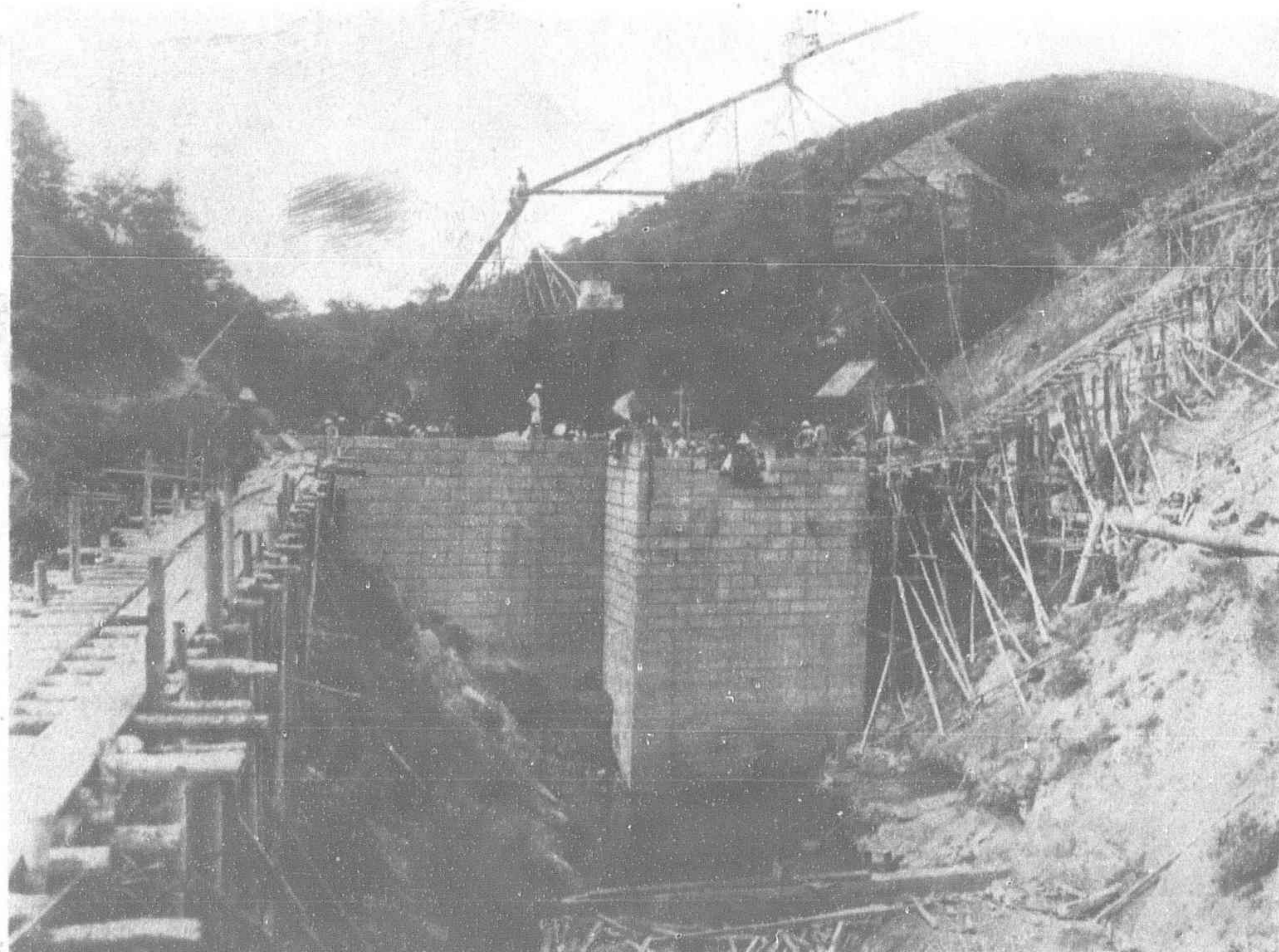


Fig. 11.—The smaller Dam for the Kowloon Byewash Reservoir

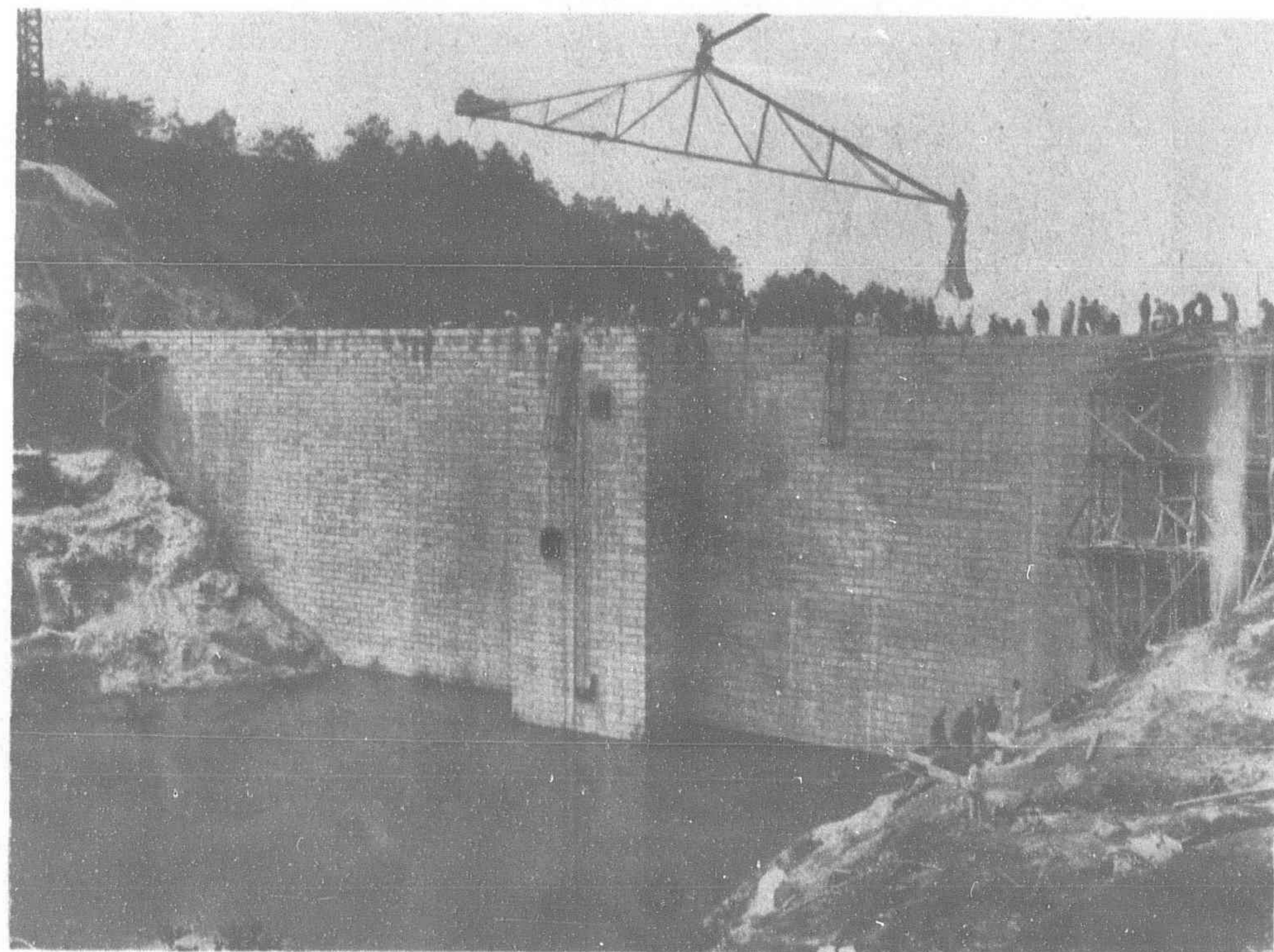


Fig. 12.—The Kowloon Byewash smaller Dam nearing completion

pipe line crossing the harbor. That line has been in service long enough to prove that the anxiety of those who believed that it would be damaged by ships or typhoon weather was groundless. The harbor water pipe line is now being duplicated.

The City of Kowloon is spreading so rapidly that it might almost be said that it will soon cover a great proportion of the land area through which runs the pipe from the service reservoir adjoining the catchment areas (shaded) to the harbor.

This diagram (Fig 2) shows clearly the enormous reserves of catchment areas and possible storage reservoirs available in the New Territories, as well as the existing sources of supply. It is well worth a detailed study. It will be referred to later as the story of the development of the supply system from the New Territories proceeds. Care must be taken, however, to distinguish between the works completed, the contracts in hand, and possible extensions.

With reference to the latter schemes it is considered unlikely that any will be carried out for many years to come as enormous additional storage provided by the Shing Mun reservoir should be sufficient for a very long time. There is, however, always the possibility of a great industrial demand for water in Kowloon. For that area is considered to be much more suitable for new factories, etc., than any land on Hongkong island.

Incidentally it may be explained that even a few years ago (say until 1920) there were many small hills that made building an expensive affair in Kowloon. Then the local Government commenced a great scheme of making flat a large area that lies between a range of fairly high hills and the sea. A huge reclamation scheme was carried out by levelling the large area of land and throwing earth, etc., into the sea. Level roads were made and many thousands of houses were soon built. Factory sites were obtainable. Building sites in Kowloon under these circumstances required but little preparation, and, on account of the large area of land available, were fairly cheap. Hitherto most of the buildings in Hongkong had involved a considerable expenditure for retaining walls, etc. That still obtains on the island, except where reclamations have been carried out, but in that case the area is comparatively limited and sites are expensive. The almost sudden development of motor

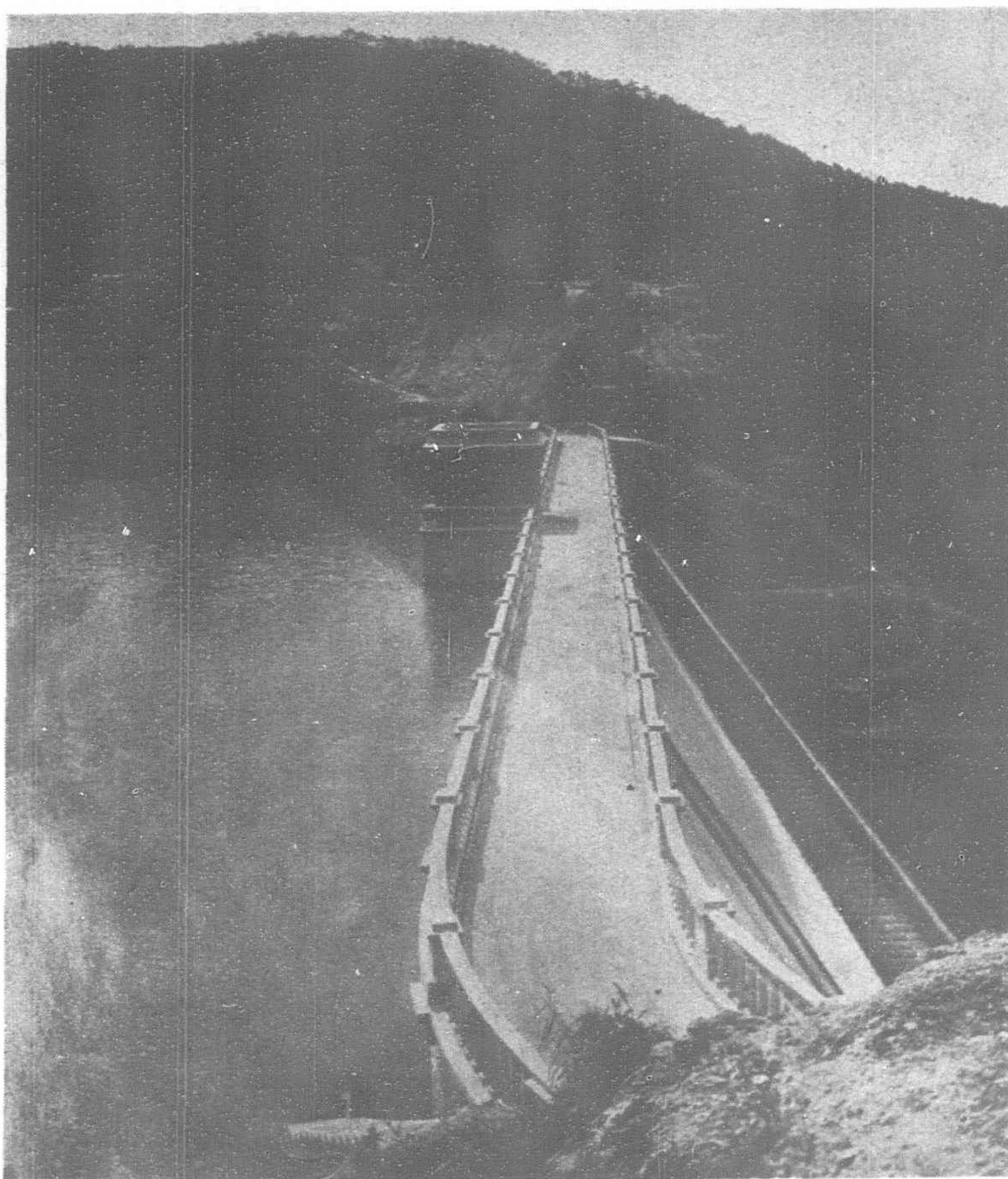


Fig. 13.—Kowloon Byewash Reservoir overflowing

transport (buses, cars and lorries) aided and encouraged the development of districts in Kowloon some distance away from the sea. And so a new industrial section of Kowloon came into being, with the inevitable result of an increased demand for water.

The first effort to provide a gravitation supply from reservoirs was, however, made before it had been anticipated that Kowloon would grow to its present dimensions. So that the early arrangements for water supply did not include the big extensions that have been carried out and planned in recent years.

### A Gravitation Scheme

We now come to consider the scheme for the supply of reservoirs for Kowloon. The original contract for the first part of the scheme was authorized in December, 1901, but the work was not completed until December, 1909. It is recorded officially that the delay was chiefly due to difficulties with Chinese contractors, but the state of local finances, or the attitude of the local executive

probably had some influence in this matter. As carried out the scheme consisted of:—

- (1) A storage reservoir of 374 million gallons capacity with a natural drainage area of 438 acres.
- (2) A caretaker's bungalow.
- (3) Two catchwaters, one intercepting the drainage of an area of 400 acres and the other of an area of 28 acres.
- (4) A clearwater channel.
- (5) A main from the storage reservoir to the filter beds.
- (6) Three filter beds having a total area of 2,400 square yards.
- (7) A main from the filter beds to the service reservoir.
- (8) A service reservoir of 2,183,000 gallons capacity.
- (9) A main from the service reservoir to Yaumati and sundry extensions of the distribution system in Kowloon Peninsula.
- (10) Miscellaneous works.

### The Storage Reservoir

This was formed by the construction of a main dam across the valley of the Lai Chi Kok stream a little beyond the five mile

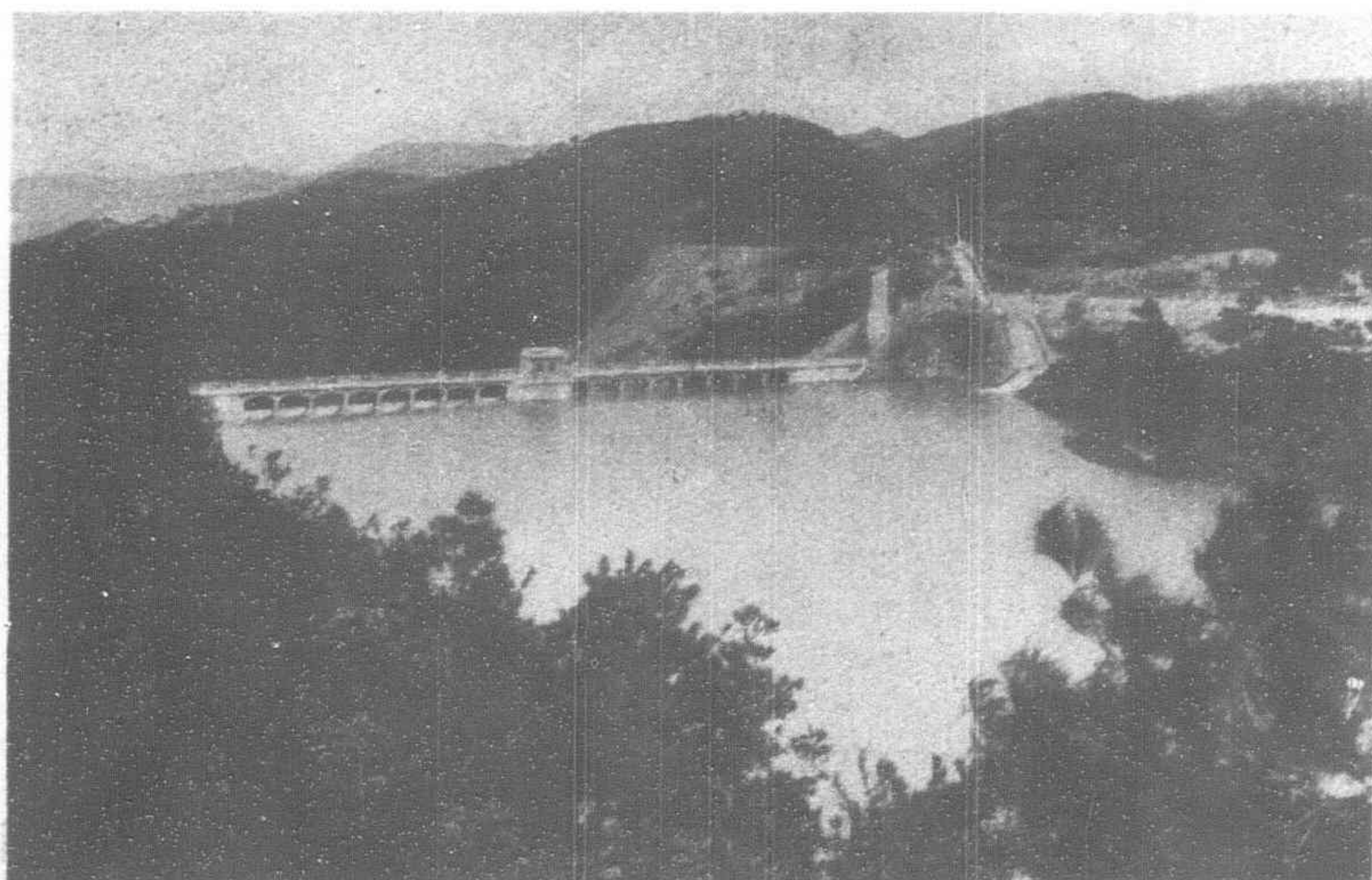


Fig. 14.—Kowloon Byewash Reservoir at Overflow

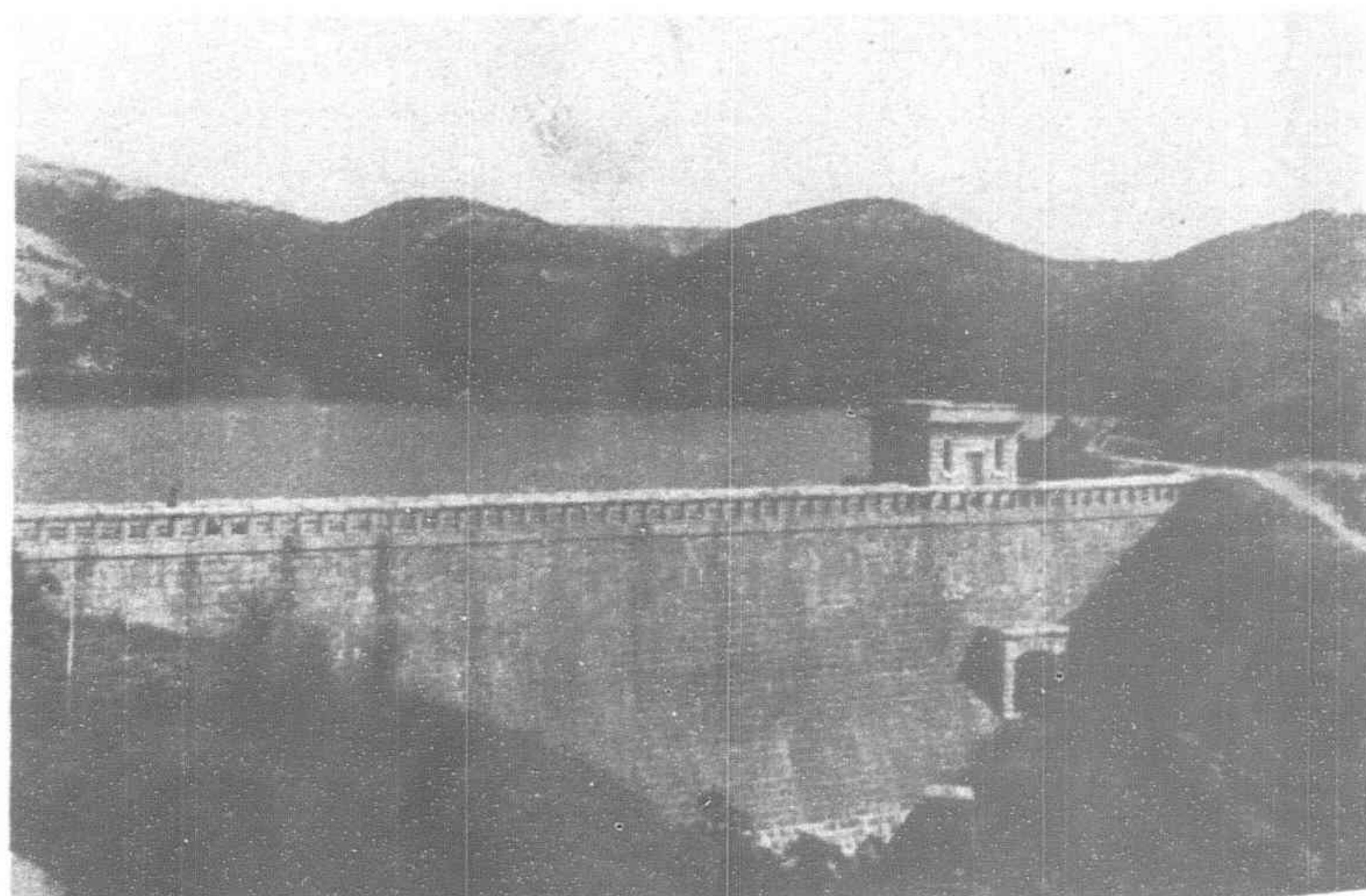


Fig. 15.—Raw Water Reception Reservoir for Shing Mun Supply

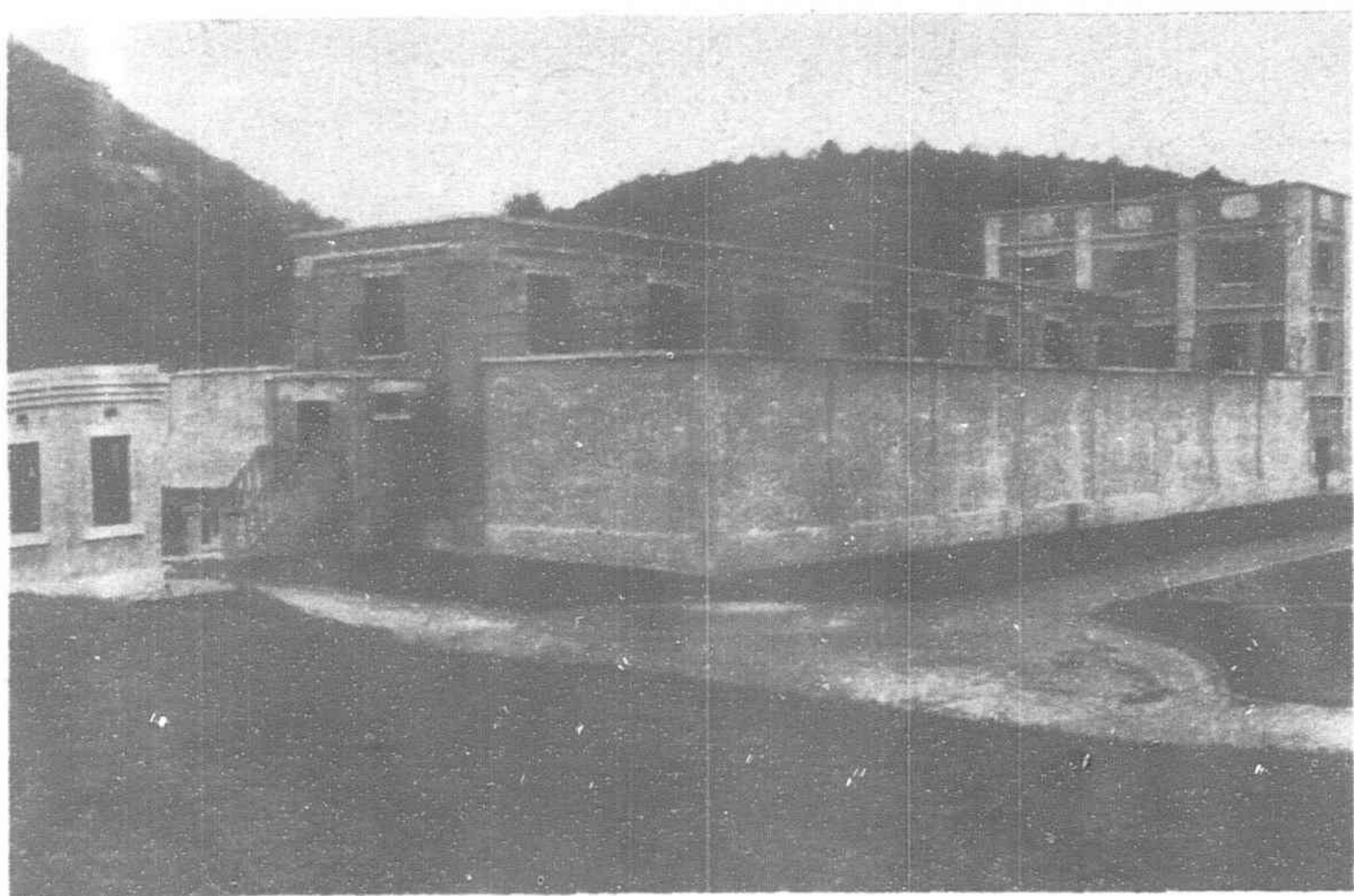


Fig. 16.—Buildings housing the Paterson Rapid Gravity Filtration Plant

stone on the Tai Po Road and an overflow dam in a depression to the south of the main dam. Both dams were constructed of masonry and concrete.

The main dam is curved on plan with a radius of 240 feet. Its length on top is 600 feet, its height from the lowest part of the foundation to the top 112 feet and its maximum thickness 72 feet. Four draw-offs, fitted with the necessary valves, are provided at the levels of 375, 395, 415 and 435 feet above Ordnance Datum respectively (permanent overflow level being 488 feet above Ordnance Datum); they are connected with a 10-in. cast iron stand pipe fixed in a well which is formed in the dam. From the bottom of the well, a culvert extends to the outer face of the dam, in which are laid a 10-in. main which is joined up to the stand pipe and a 12-in. scour pipe which served the purpose of enabling the height of the water to be controlled during construction and is now available as a wash-out for the reservoir.

The dam is composed almost entirely of cement concrete, faced on the inner side with granite ashlar masonry and on the outer side with granite rubble masonry. In the top 21 feet and at both ends, where the dam extends well into the hillsides, lime concrete has been substituted for cement concrete. Immediately behind the ashlar masonry of the inner face, cement concrete of special quality (proportion 1:1½:3), varying from five feet thick at the bottom to two feet thick at the top, has been used for the purpose of ensuring watertightness. As an old pathway across the hills to Shing Mun and Tai Po crossed the site of the reservoir and therefore became submerged, it was necessary to make other provision for it and this was done by forming a path, nine feet wide, on top of the dam, which is at a level of 454 feet above Ordnance Datum.

The following are the quantities of material used in the construction of the dam:—

Cement concrete	..	..	..	..	36,740	cu. yds.
Lime	..	..	..	..	4,420	..
Ashlar Masonry	..	..	..	..	64,520	..
Rubble	..	..	..	..	1,750	..

The overflow dam is 120 feet long and 23 feet high from the lowest part of its foundation to overflow level, the path already referred to being carried across it on a bridge nine feet wide supported on granite ashlar piers. The overflow comprises 10 openings, each 10 feet wide, all of which are provided with iron sluices, by means of which an additional depth of two feet of water in excess of that held up by the dam can be impounded. These sluices are used only when there is no danger of a sudden rush of water into the reservoir due to typhoon rains, which would be dangerous. Below the overflow dam are two "water cushions" to break the fall of the water; and beyond them a channel, varying in width from 120 feet to 60 feet, has been cut for a distance of 300 feet and lined with concrete and masonry. Clock-work recording gear has been provided to register the extent of any overflow which may occur.

In addition to the provision made for it in the case of the two dams, the diversion of the old pathway necessitated the formation of 1½ miles of new path, varying in width from six feet to four feet. It consisted merely of a cutting in the hillside of the width stated, with the necessary cross drains where required.



Fig. 17.—Operating Corridor of Paterson Filtration Plant

The construction of the reservoir also entailed raising the level of the main road to Sha Tin and Tai Po for distance of nearly half a mile to an average extent of one foot six inches.

### Catchwaters

The natural catchment area of the reservoir, as already mentioned, is only 438 acres, the yield from which would be insufficient to fill a reservoir of such capacity in years of low rainfall and it was therefore necessary to supplement it by means of catchwaters. The main catchwater commences near the east end of the reservoir. Passing under the Tai Po Road it is carried for a distance along the northern slopes of the Kowloon range of hills, terminating at the stream which flows northward from the Lion's Head or Kowloon Pass. It intercepts the water from an area of 400 acres and, except where crossing stream-courses, is cut entirely out of the solid. Commencing with a cutting in solid rock through a gap in the hills, it has an average width of 21 feet and depth of 7-ft. 6-in. diminishing gradually to 15 feet by eight feet at its upper end. A small V-shaped channel is formed at one side to carry the dry weather flow; and pits, extending the full width of the channel, are constructed at intervals of 200 feet to intercept any grit that may be carried by the water during rainstorms and overflows are provided at most of the points where any considerable streams enter the catchwater. A path, six feet wide, has been constructed on the outer bank of the catchwater and is carried across the overflows by concrete bridge. The bottom of the channel is lined with cement concrete 4-in thick and the sides with lime concrete of the same thickness. The catchwater has a fall of 1 in 2,400 and when running full it is calculated that it will carry 20 million gallons an hour. This capacity was provided so that it may in future be extended to intercept the water from a further area of 600 acres, or 1,000 acres in all, and it is designed to carry a rainfall of 1-in. per hour from the last mentioned area. A clockwork recorder has been provided to register the depth of the water flowing in the catchwater.

The second catchwater, which is 500 feet long, with a sectional area of seven square feet, intercepts a stream with a drainage area of 28 acres near the Caretaker's Bungalow and discharge into the Reservoir at the Byewash Dam.

### The Clearwater Channel

To avoid drawing water from the Reservoir when, after heavy rains, it may be too turbid to be easily filtered, a channel has been constructed to intercept a portion of the flow from the catchwater in addition to the waters of a natural stream and convey them into the main leading to the filter beds. This channel extends from the catchwater to the overflow dam, contouring the hills on the south side of of the reservoir and just above top water level. It is 2,000 feet in length, has a sectional area of 2½ square feet and a fall to 1 in 1,200 and is lined throughout with concrete, the bottom being of cement and the sides generally of lime concrete. Where spurs of the hill would cause any considerable detour, they have been cut through 15-in. stoneware pipe being laid to conduct the water between the points where the channel ends. An intake has been

formed in the bed of the catchwater from which the water is conveyed in 12-in. cast iron pipe into the channel and the waters of the stream already mentioned are intercepted in a similar manner. From the overflow dam, where the channel terminates, the water is conveyed in an 8-in. cast iron pipe, which passes through the dam, across the Overflow Channel in a diagonal line and extends down the hillside to the main gauge on the pipe-line leading to the Filter Beds.

The total cost of the scheme was \$1,237,850.

### Execution of Scheme

The whole of the works described above were designed and supervised on behalf of the Government by Messrs. Denison, Ram & Gibbs. The reasons for entrusting the work to this firm were the inadequacy of the staff of the Public Works Department and the fact that Mr. Gibbs, whilst occupying the position of Assistant Engineer in the Public Works Department prior to joining the firm mentioned, had investigated and reported upon the possible sources from which a supply of water for Kowloon Peninsula could be obtained, the scheme in question being evolved from his report.

In spite of the rapid growth of Kowloon, very little attention appears to have been paid to the problem of increasing the water supply until 1920 when Mr. Henderson investigated the whole problem of water supply for the island and the mainland.

As a result of his Report the Shing Mun Supply was brought into Kowloon.

A glance at the map (Fig. 2), which shows the Shing Mun Valley area, makes it obvious that an almost unlimited water supply can be obtained from the new Territories.

The main feature of the scheme which has been, and is being developed, is utilization of the Shing Mun River and the large catchment area around the hill (or, as it is locally called, mountain) named Tai Mo Shan.

### The Tai Mo Shan Catchment

This Peak rises to a level of 3,130 feet and is the highest in the district. There are other hills nearby which assist to extend the available catchment area. And it has been noticed that the best records of rainfall are those in the neighborhood of the higher levels.

Nature arranged that, for centuries the main drainage of this high level catchment area should be through the Shing Mun Valley. What is called the Shing Mun river carried away a torrential stream

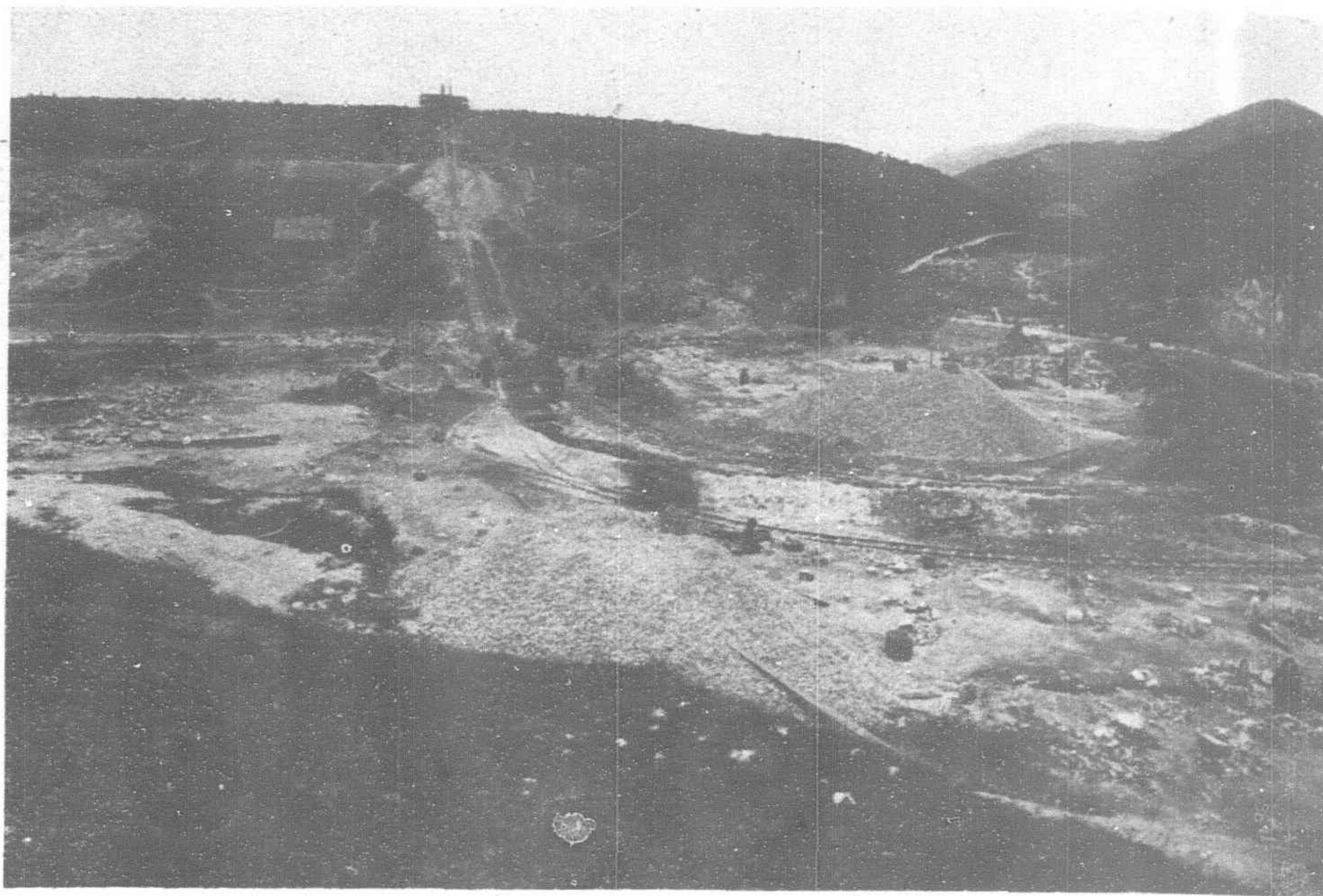


Fig. 18.—Initial stages of construction (1929) of the Shek Lui Pui Reservoir

in typhoon weather and a rather insignificant trickle of water in the dry season.

During 1933 the rainfall registered by the various waterworks' rain-gauges were generally greater than that recorded at the Observatory. It can be said that generally the record of the highest situated rain gauges show the greatest rainfall; and it frequently happens that at Shing Mun that relatively heavy falls occur, presumably owing to the proximity of the mountain Tai Mo Shan which acts as a condenser.

There was a striking instance of the excess rainfall in the district on April 20, 1931, when the railway disaster between Shatin and Taipo occurred, due to a washout. An extraordinarily severe cloudburst appears to have traversed the southern slopes of Grassy Hill and Tai Mo Shan, and from surface indications it would seem that the point of greatest intensity was within the drainage area of the stream passing Lo Wai Village, above Tsun Wan. Tai Mo Shan was scarred to the bone by this stream which in places cut away every vestige of soft material for a width of 50 yards.

Unfortunately the Shing Mun River rose to such a height (about 20-ft. above normal) that the recording apparatus at the intake was flooded and no maximum results were obtainable.

It has been conservatively estimated that not less than 5-in. of rain fell in one hour during this storm, and enquiries made at the various villages proved that never in living memory had such a storm been experienced.

### Rainfall in China

One of the most important factors in designing any water supply system is the record of rainfall, over a number of years, in the district. That record has been kept in Hongkong and enables the authorities to estimate the storage requirements, etc.

It is of interest to record the fact that provisional monthly rainfall maps of China have been constructed; principally from data published by the Zikawei Observatory, and the records from stations of the Chinese Maritime Customs.

The results show that the wettest area is near the mouth of the Yangtze in January, becoming more and more south, until in May the wettest district is a little to the north of Hongkong. In June it is farther north, and in July is in the neighborhood of Pakhoi; in August and September it is apparently slightly to the south of Hongkong. In October and November it lies over the lower Yangtze Valley, and in December its position is doubtful, but probably somewhere between the

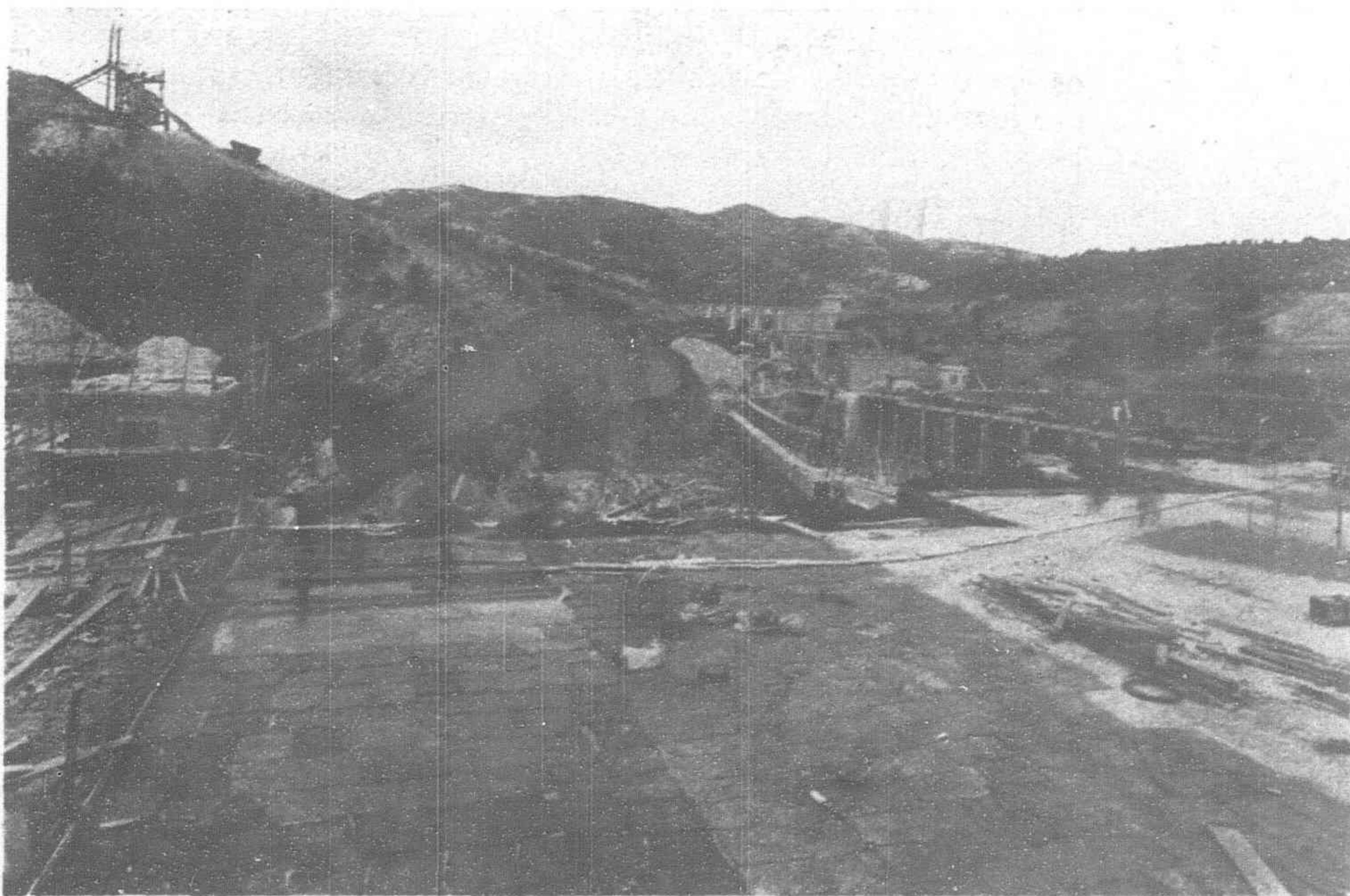


Fig. 19.—Building the Shek Lui Pui Service Reservoir

lower Yangtze Valley and the south coast of China.

The driest area is in the neighborhood of the Gulf of Pechili in each month. The wettest month is June and the driest is December.

### New Reservoirs for Kowloon

In 1924 contracts were let for the construction of tunnels for its Shing Mun Valley scheme and tenders were received from several British firms for filtering.

There are now in existence a chain of reservoirs within easy distance of the original Kowloon reservoir. There are the Byewash Reservoir (185 million gallons) the Shek Li Pui Reservoir (116 million gallons) and the Raw Water Reception Reservoir (33 million gallons) into which the Shing Mun supply falls before filtration.

Of these the Kowloon Reservoir is connected only to the Kowloon distribution system. The other three can be used either for Kowloon or for the harbor pipe line.

The Bye-wash Reservoir is (Fig. 3) as its name implies, at a lower level than the Kowloon Reservoir. The total estimate for its construction was \$350,000 (Hongkong currency). Trial trenches were cut in 1925 and plans for the dam, etc., put in hand. The reservoir catches the water that comes over the spillway from the latter. The dam is, for all intents and purposes, the same as that which retains the water in the Aberdeen Upper Reservoir on the island. It was completed in 1931 and provides an additional 185 million gallons storage.

The series of pictures (Figs. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14) showing details of various phases of the construction of this reservoir are of interest. They explain themselves and reveal the general lie of the country and the methods employed in dam construction in Hongkong.

Two dams were built to form this reservoir.

Incidentally it may be mentioned that the cost of civil engineering work of this nature in the Far East is much less than in Britain or North America.

### From Shing Mun to Kowloon

The approval of the Secretary of State for the Colonies in London, for the immediate construction of the first part of the Shing Mun Valley scheme, was obtained in May 1924 and was at once proceeded with.

The work on this scheme consisted of an intake dam across Shing Mun river, with 6,000 feet of temporary conduit; the North

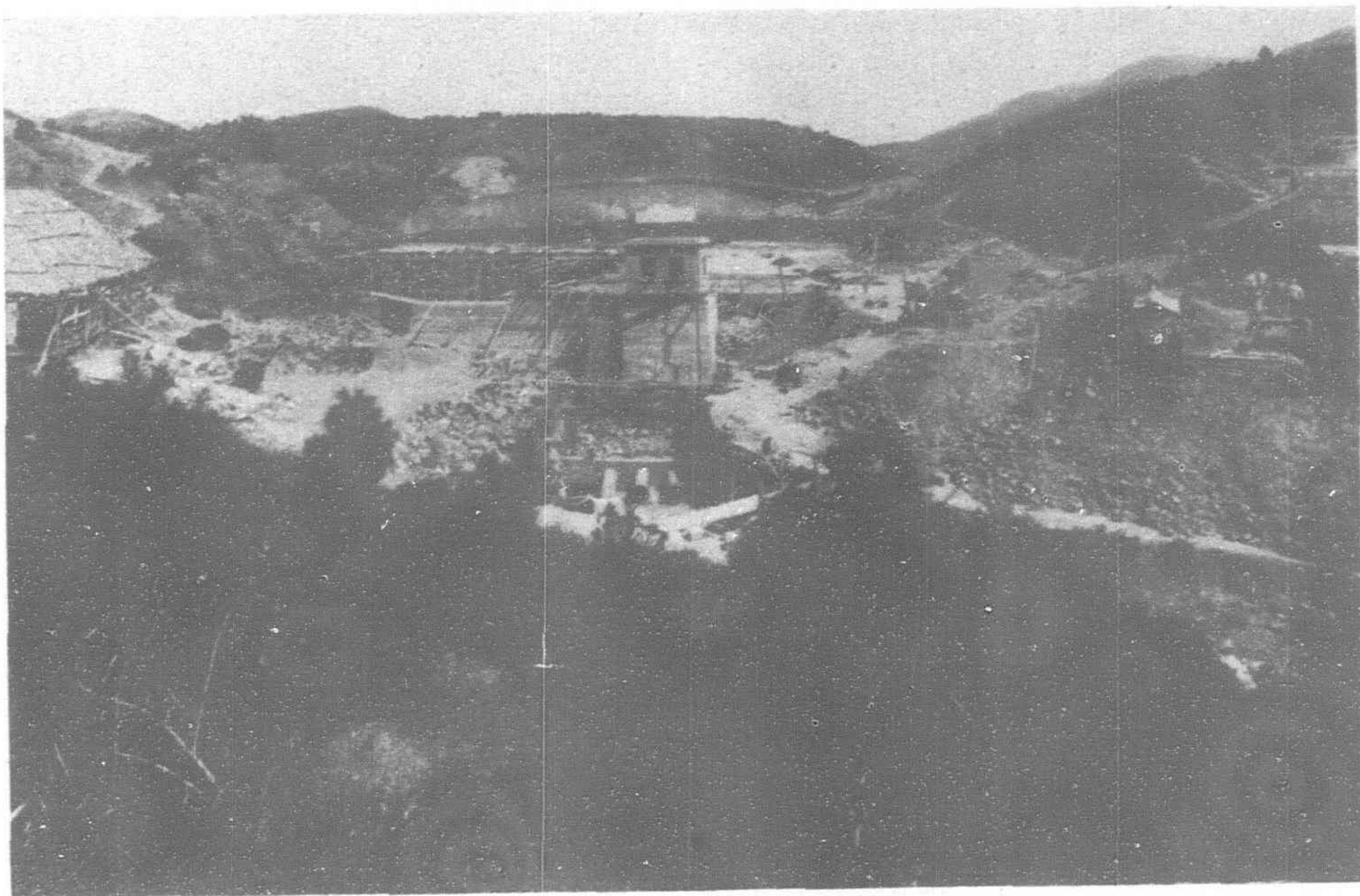


Fig. 20.—Another view of work of constructing the Shek Li Pui Service Reservoir

Conduit 2,900 feet long; the South Conduit 2,000 feet long; two tunnels, totally 6,840 feet in length; a raw water reception reservoir in the lower Shek Lai Pui Valley to hold 33 million gallons (Fig. 15); a filtration plant to deal with five million gallons a day; a covered reservoir, to hold five million gallons; a 24 inch trunk main 4.4 miles long to Kowloon Point, with a feed to the Kowloon system, at Piper's Hill to hold  $1\frac{1}{2}$  million gallons; the pipe line on the bed of the harbor, 1.1 miles long; a 24 inch main from the island shore, to connect the harbor pipe line with the covered reservoir, distant 0.6 miles from the shore in the Botanical Gardens.

### Preliminary Work

As soon as it was decided to go ahead with the Shing Mun scheme, resumptions of land in the district were made. Small farmers were generously compensated and provided with other land and dwellings, but it was very difficult to persuade them to move from ancestral plots of land. The access road from Tsun Wan to Pine Apple Pass (since reconstructed for heavier traffic) was built.

A temporary intake and conduit was capable of delivering 10 million gallons daily to the North Conduit, the length being 6,030 feet and the grade uniform at 1 in 272.

The intake dam overflow sill stands at 515 above sea level; the dam is of cement concrete, the length of sill being 50 feet. The dam is only 34 feet from lowest foundation level and is  $115\frac{1}{2}$  feet long.

The North Conduit (\$70,801) connects the temporary conduit in the gorge with the north tunnel at Smuggler's ridge. The grade is uniform being 1 in 1930 and the conduit can deliver 20 million gallons a day.

### British and Chinese Contractors

The well-known firm of Messrs. Armstrong, Whitworth & Co., famous as engineers and ship-builders, developed a civil engineering branch and obtained the contract, in 1924, to construct the two tunnels and the South Conduit. This work cost rather more than a million dollars.

This work was carried out by their representative, the late Mr. Warren, who was well known in British engineering circles as the man who, after the war, carried out the difficult task of destroying the concrete works on Heligoland island, which had been erected for defence purposes by the Germans.

The north tunnel pierces Smuggler's ridge; the rock met with was mostly granite of varying hardness with intrusions of soft green stone. It was necessary to line several short lengths of the tunnel with cement concrete.

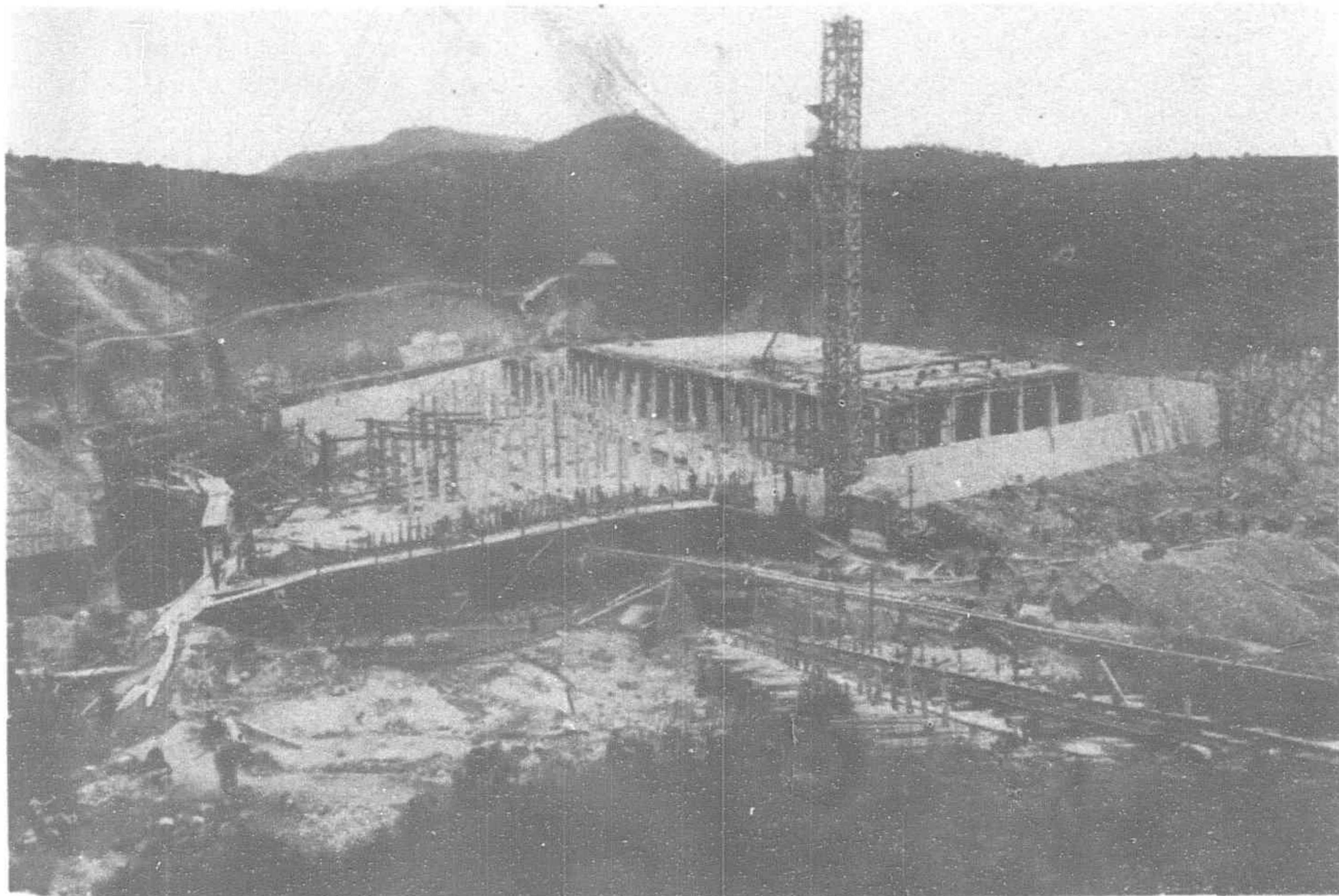


Fig. 21.—Shek Li Pui Service Reservoir in course of construction (1930)

The south tunnel did not require lining, as granite of good quality was found throughout. The work was carried out in a satisfactory manner but it is generally believed that the contractors lost money. The civil engineering (contractor's department) of the well-known British firm proved a financial failure a few years later, and was closed.

Another firm of British contractors (Trollope and Colls (Far East) Ltd.), built the Reception Reservoir (\$170,208) to enable holding 33 million gallons.

The Paterson Engineering Co. (England) supplied and erected the chemical and mechanical apparatus for the filter plant (£11,601). Figs. 16 and 17. This is larger, but otherwise very much like the plant described and in use at Bowen Road on the island. The existing plant, which will shortly be duplicated, is capable of dealing with million gallons per day. Electric power is available for the machinery, although the head of water is used to obtain free power by means of a water turbine.

A covered service reservoir adjacent to the plant, has a capacity of 11.4 million gallons. The area occupied is about two acres. Figs. 18 to 22 show this reservoir in various stages of construction.

A Chinese contractor (Ng Wah) built the Pipes Hill Service Reservoir (\$140,000). The top water level is 275 feet above sea level and the depth when full is 18 feet three inches, capacity being 1.547 million gallons. The roof is of reinforced concrete.

### Shek Lui Pui Reservoir

The construction of this additional storage involved moving villagers, costing \$57,200. The total estimate for the reservoir (including above) were \$260,000.

The reservoir has a storage of 100.7 million gallons, below overflow level (645 feet above the sea) and the lowest point of draw off, but in addition 15.3 million gallons can be utilized in emergency through the wash out pipe. The top water area of the reservoir is 15½ acres.

The reservoir commenced to fill in June 1925. The leakage is small and drains either into the Kowloon Reservoir or the new Reception Reservoir in the lower Shek Lai Pui Valley. The main dam is 73 feet high, and has an overall length of 310 feet.

This reservoir was built by the Hongkong Engineering and Construction Co., Ltd., but their tender was so low that the company lost a considerable amount of money on the work. There are three dams to hold the water, two of them quite small.

There are two outlets, one from the main dam that sends water to the Kowloon Reservoir the other sends water to the Shing Mun Reception Reservoir.

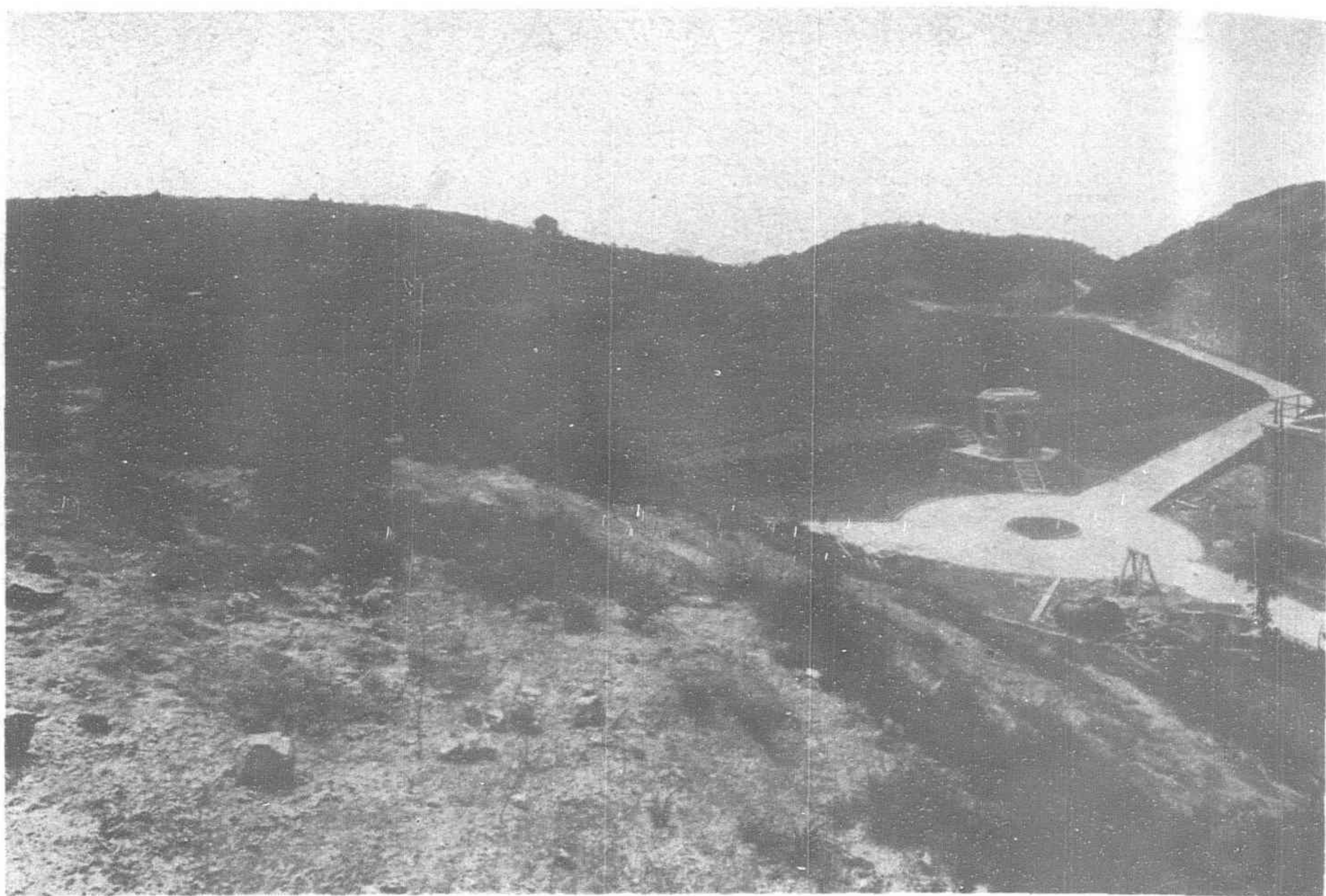


Fig. 22.—Covered Service Reservoir completed at Shek Lui Pui

The Shek Lai Pui Reservoir is situated on very high ground and one of the most beautiful views of the district rewards the enterprising visitor. In addition to the storage already mentioned, a covered storage reservoir on Yaumati hill was completed in March, 1934; this holds five million gallons. The above details give a fair idea of the great efforts that have been made, in recent years, to increase the supply of water to Kowloon.

### Problems of Consumption

From all that has been explained in these articles on the Hongkong Water Supply it will be realized that the technical problems have not been easy of solution. Nor have the financial difficulties been easily overcome for quite apart from the heavy initial expenditure on works, there is the constant upkeep and supervision necessary for the efficiency of the supply system. One of the greatest problems has been that of devising a fair system of payment by the consumer.

It will be realized that there is not only the ordinary household to be considered. Large volumes of water are used for trade purposes. And millions of gallons each year are supplied from the Kowloon reservoirs for the ships that replenish their tanks as they lay in Hongkong harbor. Indeed, this matter of a reliable supply for ships is of paramount importance in the case of a terminal port, as is Hongkong.

One of the subjects of controversy in Hongkong, almost from the commencement of the system of public water supply, has been this problem of the method of payment by the consumer. At first there was a general water-rate, the consumer's contribution varying according to the assessment of the premises, i.e., their rentable values. But, to be equitable, that system involved the obligation of a continuous supply for every one; experience showed on occasions, that a continuous supply was not possible in very dry weather, with a limited storage capacity.

This problem of equitable charges for water has worried the local Government almost from the beginning of the public supply. But as the demand for water so rapidly exceeded the supply it became more acute. And we find records of the Government's grave difficulties prominent in the local press at the commencement of this century.

An exceptionally low summer's rainfall (1901) had produced a disastrous water famine, and in the Spring of 1902 the scarcity of water had come to such a pass that the Government had to bring water to the island in lighters from the mainland. Drastic measures of restriction were proposed, and

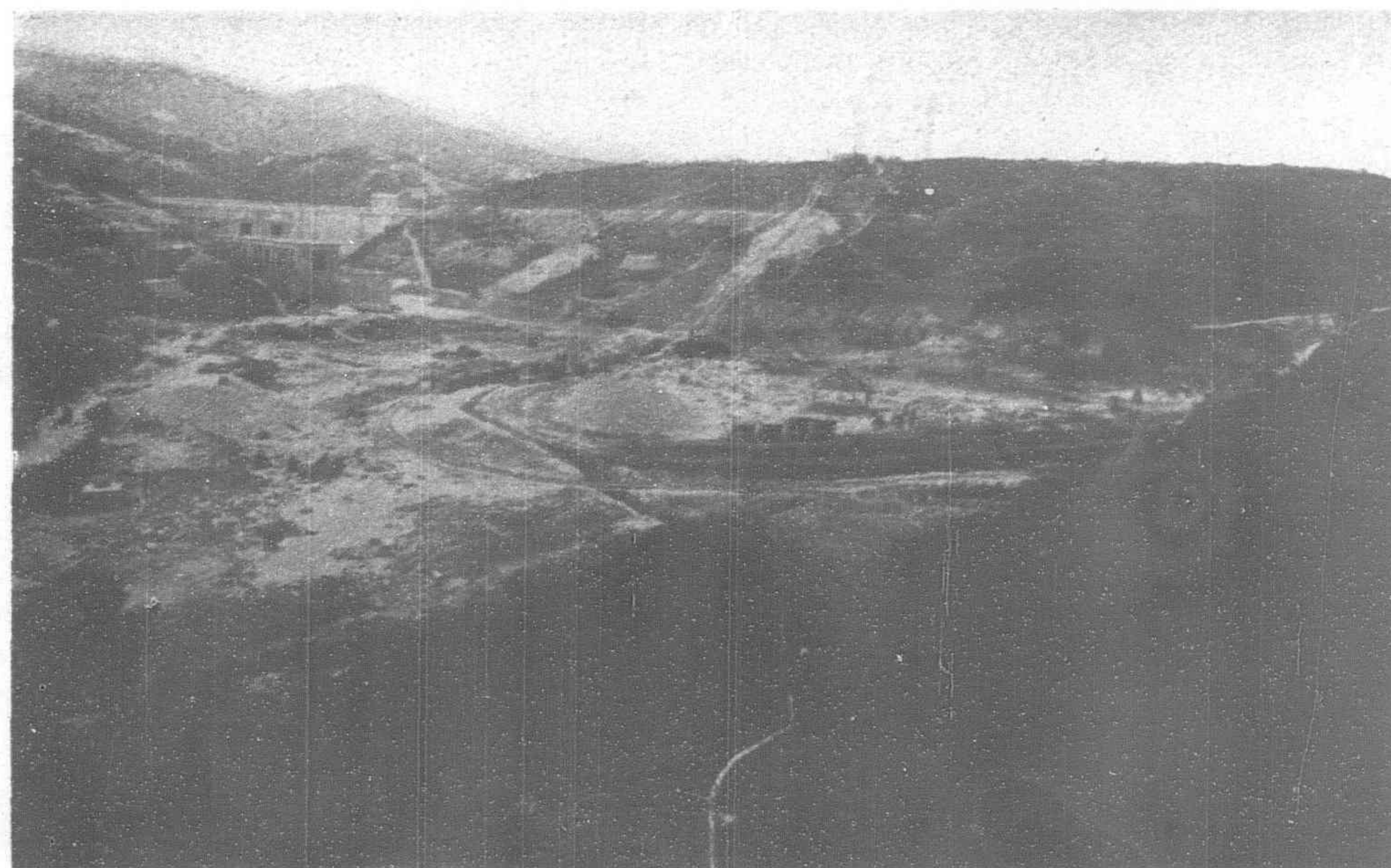


Fig. 23.—Showing the initial stages of work on the Shek Lui Pui Reservoir

in 1902 the local Government introduced and passed a bill providing that all tenement houses should obtain their water from public taps. The Secretary of State, however, disallowed the ordinance. The Consulting Engineer to the Crown Colonies, Mr. Chadwick, suggested the control of water by a system of "rider mains" and the introduction of meters on all services connected with the principal mains. This was arranged.

In effect that system meant that when there was anxiety about water supply the tenants in tenements found the supply cut off in their houses and they had to obtain water from public taps in the streets. One of the reasons for the system was the belief that there was great wastage in tenements due to carelessness and faulty taps. In 1933 a system of universal meterage was introduced. It has proved to be very unpopular, but there can be no doubt that it makes householders much more careful.

The following words spoken by H.E. Sir William Peel, the Governor of Hongkong, at a meeting of the Legislative Council held in October, 1933, shows the attitude of the local Government on this subject of water charges.

He said:—"The question of charges for water supply is one which will have to be seriously considered during the next year or two. We have undertaken to make our water supply self-supporting and, as you know, we are spending very large sums on this vital service. My own feeling is that there should be no free allowance, and that all water consumed should be paid for, though I would give a maximum allowance to each house at a very low rate and charge higher rates on a sliding scale for water consumption in excess of such allowance. I think that such a system is necessary to bring home to consumers the necessity for avoiding waste. I would prefer, however, to make no change until our waterworks are further advanced."

### Prevision Means Provision

The senior member of the Legislative Council, Sir Henry Pollock, said "The water shortage of the past few years have been sufficiently serious to make any neglect by the Government to ensure, to the best of its ability, that there shall be no delay in construction which is due to preventable causes, liable to severe comment."

The Colonial Secretary said as regards the Shing Mun Dam "the Resident Engineer hopes to be able to achieve some storage towards the end of 1935 but here again the stability of the dam as a whole must take priority. I may add that the new siting of the dam is expected to increase the total storage by two hundred and fifty million gallons."

At the same meeting Sir Henry Pollock mentioned the anxiety of the public concerning the "considerable rate of sickness from malaria" amongst the workers in the Shing Mun Valley. Dr. Wellington, in reply, dealt with this problem of eliminating malarial mosquitoes. He did not explain why the work was not put in hand years ago. One has the uncomfortable feeling that the workers at Shing Mun Valley have suffered from malaria which could have been greatly reduced, if not entirely eliminated, if the work now carried out had been put in hand years ago.

### Water Shortage Crisis of 1929

We must remind readers that the worst record of water shortage in Hongkong occurred in 1929. Fortunately there was no epidemic, such as the dreadful plague of cholera in 1902. But eventually the situation became so serious that total restrictions were placed on water from the mains.

It is of interest to note that, on account of this water shortage, Hongkong figured in the head lines of newspapers all over the world. Cables flashed the news everywhere. It is related that a San Francisco firm cabled the Hongkong Government an offer to supply water in five gallon jars at gold dollars 1.90 a jar! If the offer had been accepted it would have been cheaper to drink imported beer!

The drought of 1929 was suddenly ended by a typhoon which brought eight inches of rain and the reservoirs were soon filled.

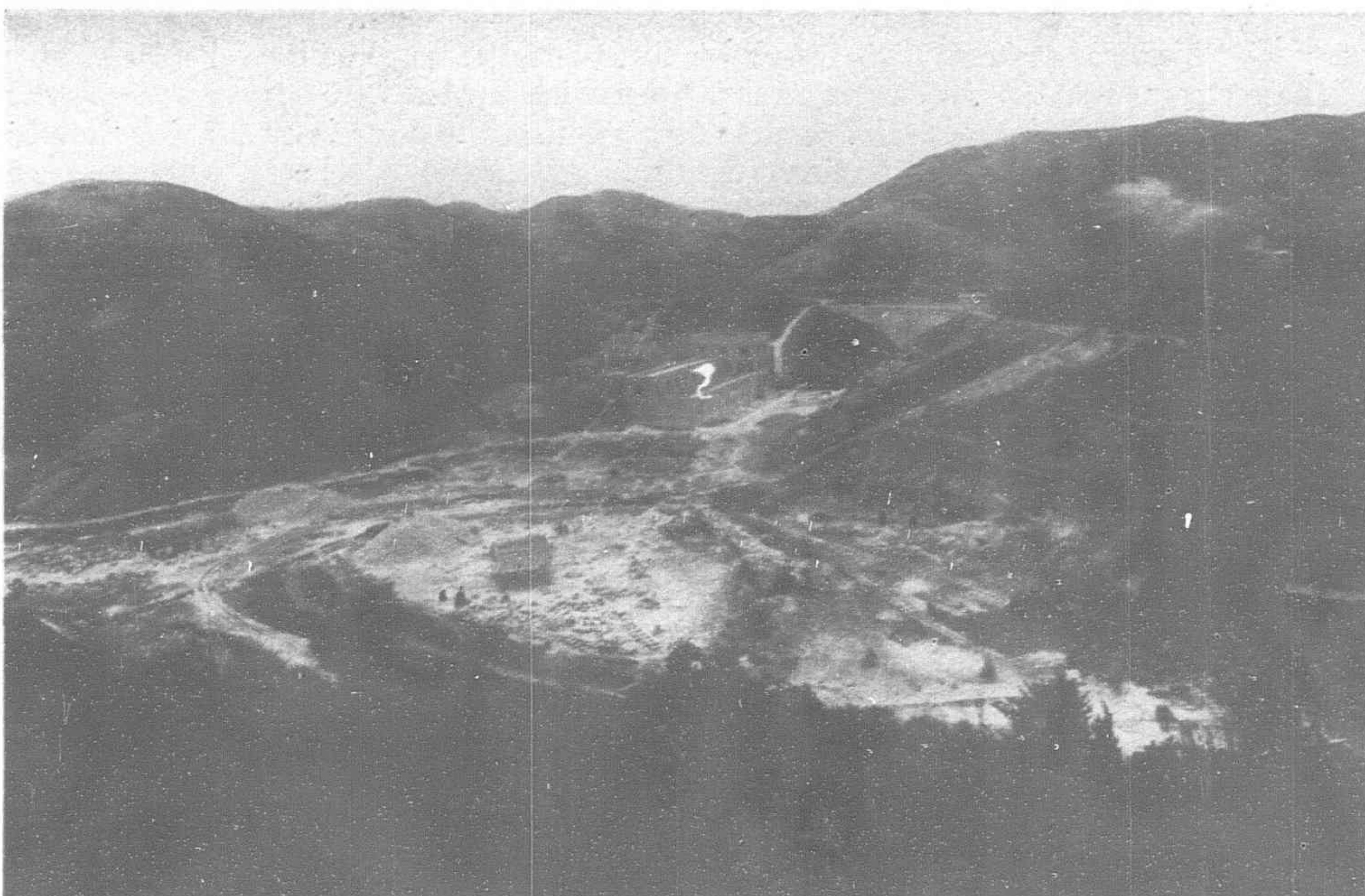


Fig. 24.—Showing excavation for the Shek Lui Pui Service Reservoir in foreground, Filtration Plant in center and Raw Water Reception in background. This Reservoir has capacity, thirty-three million gallons

During this year (May 1934) there were restrictions of supply. It is unlikely that we shall entirely escape this nuisance right throughout the year until 1938 when it is hoped that the Shing Mun dam will be completed.

### Quality of the Water

It is essential that, for the preservation of public health, the water should be absolutely pure. It should be understood that extensive precautions are taken to ensure that the water supplied is filtered. Every day samples of water are taken from the city mains by the Medical Officer for Health and reports upon the samples are issued.

Until recent years all of the filtering was done by means of sand beds through which all of the water for distribution was passed. At periodic intervals the sand was removed, washed and then replaced. An alternative method is what is termed the mechanical filtration system. The former system has some advantages, although the latter system is becoming popular. The sand beds take no power and are, as compared with the mechanical filter system, inexpensive to work. That method, however, requires much greater area of land for the treatment of the same quantity of water. And flat land, essential for sand filters, is valuable in Hongkong especially on the island.

The Water Authority in Hongkong is gradually replacing this sand bed system by mechanical filters. The latter involve the use of compressed air, water pumps and chemicals.

In appearance the sand beds in the two systems are very much the same. But the mechanical system involves buildings and machinery. More care is needed in grading the sand, etc., for the mechanical system. There is a difference in the method of cleaning the sand. This must be removed from the filter bed and washed in the older system. In the mechanical system, pipes with small nozzles are laid beneath the sand beds. For cleaning the sand compressed air is first admitted to the pipes and then water under pressure.

### Filtered Water

Although more expense is involved in the installation of mechanical filters than in the old system, except in the purchase of land, yet it is noticeable that the mechanical method is greatly favored by water engineers. It seems certain that, in due course, it will entirely replace the old system in Hongkong.

The surface water derived from the catchment areas and stored in reservoirs is very soft, the average hardness being 2.5 parts per 100,000 and varies enormously the water having a very high pollution index at the beginning of the rainy season. The method employed in deciding the freedom of the water from germs producing diseases such as typhoid, dysentery, etc., is to take a

sample of the water and to determine whether there is present in it any of those germs which go by the technical name of *Bacillus Coli Commune* (B.C.C.). These germs are sometimes called "Colon Bacille"; the meaning of both scientific terms is that the germ is an organism which carries contagious disease. Specimens of these germs are always present in human or animal excreta, and therefore if any of the excreta gets into the water supply the germs may be carried to the consumer of water and cause serious, if not fatal, sickness. The usual practice is to take a small sample of the water and examine it for the presence of germs.

It is obvious that if a very small quantity of water, such as 0.1 centimeter, be taken for analysis there is less possibility of finding a *Bacillus* in it than if a larger quantity is taken; and it is in this way that the medical officers determine whether the water is fit for human consumption or whether it may be a dangerous carrier of disease.

In this connection it is of interest to relate that in the year, 1924, there was an epidemic of typhoid fever in Hongkong with alarming results. Public opinion was stirred because of the number of casualties and an investigation was ordered. It was generally believed that owing to certain road improvements which were being made on the Peak that the water in one of the reservoirs become contaminated although there was no direct evidence to that effect. In any case the presence of germs in that local water was not detected.

It may be of value to relate the system employed by the medical office of Health in Hongkong and to give some data concerning his work.

After storage this water undergoes a remarkable degree of self-purification; especially on the Kowloon side: raw water in the Kowloon reservoir has been as good as B.C.C. absent from 22 C.C.; reservoir water on the Hongkong side is usually not up to this standard. Raw water on the Hongkong side, however, occasionally reaches a good standard of purity equal to B.C.C. absent from 11 C.C.—a very good standard indeed for raw water in China and this is doubtless due to the self-purification made possible by the prolonged storage, as long as six months or more sometimes elapsing without any considerable addition. This far exceeds Houston's "safety" storage figure of two months as regards typhoid or other pathogenic bacilli of a similar type.

### Filtration Methods

The island of Hongkong is provided with eight sets of filter beds distributed at various points on the hillside above the city of Victoria. Five of these are connected to the various reservoirs, so that when supplies run short in any particular reservoir, water can be drawn from others and conveyed to any filter bed as required. Kowloon is provided with one slow-filtration plant also with a Paterson's "rapid gravity" plant in connection with the Shing Mun Valley scheme.

The quality of filtered water varies according to the type of filter and the rate of filtration, which is of course dependent on the public demand. It is also in a lesser degree dependent on the quality of the raw water delivered which varies enormously and has to be carefully watched.

Raw water may be anything from B.C.C. present in 0.1 C.C. (smallest quantity of water taken for analysis) in the early part of the rainy season up to B.C.C. absent from 22 C.C. (largest quantity of water taken for analysis) after prolonged storage.

Filtered water as it leaves the filters, and before chlorination, is examined weekly both chemically and bacteriologically; results show the water from the Paterson's "rapid gravity" filters to be exceptionally good. The raw water is sedimented by means of alumina sulphate and lime, the quantity added varying according to the transparency of the water. This is not high as it rarely exceeds one grain each of alumina and lime per gallon. The amount used is often much lower, as would be expected when the raw water consists of stored rain water. Samples of water from these Paterson's filter reach the very high standard of B.C.C. absent from 50 C.C. of water (largest quantity of water taken) in about 50 per cent of samples taken, the remainder (with a few exceptions) being up to the standard of B.C.C. absent from 25 C.C. of water.

Samples of water taken from the most up-to-date sand filters mentioned above occasionally reach as high a figure as low as B.C.C. absent from 50 C.C. in 2.5 C.C. A fair average for these filters is B.C.C. absent from 16.6 C.C. of water.

The older sand filters are now being gradually improved or replaced by more modern types. They have done long and faithful service and have been at times subjected to much misuse, besides being hopelessly overworked in the past, when the demands for water far exceeded the capacity of the filter beds. This has now been largely remedied and at present the Water Authority is able to keep pace with the demand for a water of reasonable purity owing both to the construction of new filter beds of an up-to-date pattern and the erection of the mechanical filters above mentioned. The old type of filters would at times give a water of the hygienic value of B.C.C. absent from 10 C.C. but they were very erratic and the pollution index frequently fell much lower. Curiously enough the Kowloon filter beds, although not specially modern, occasionally produced a water up to the standard of B.C.C. absent from 50 C.C. The inhabitants of Kowloon have always been fortunate in their water supply. This fact is taken full advantage by the shipping of the Port who draw their water supplies exclusively from the Government installation at Lai Chi Kok, which is supplied from Kowloon.

### Distribution of Water

All filtered water is chlorinated before entering the distributing mains, the quantity of chlorine added varying, according to the filters and the quality of their output, from  $\frac{1}{4}$  part per million in the effluent from the best filters, up to one part per million in some of the older types of filters (especially when they have to be worked beyond their normal capacity). The chlorine is added by means of the Paterson Chloronome after filtration. The chlorinated water then passes into the storage tanks to feed the mains.

From four to six samples of tap water are taken daily at different points by the Government Bacteriologist. For the purpose of this routine work 50 C.C. of tap water is examined from each sample. The present system as regards tap water supplies is to put 10 by 10 C.C. tubes and 1 by 20 C.C. tube of the water in a McConkey bile salt lactose media, using Durham's fermentation tubes with neutral red as indicator; the 10 C.C. tubes contain double strength media. The samples are examined after 24 hours incubation at 37° C. and should any samples show indications of lactose fermenters being present in less than 10 C.C. an advance report is at once sent to the Water Authority who investigates the particular water service main, tap, street fountain, etc., remedies defects if any and notifies the Bacteriologist, when a second sample is taken from the same place. Usually the cause of the sample taken on the following day is up to standard.

Tap water supplies are reported upon to the Director of Medical and Sanitary Services after 48 hours incubation at 37° C. Any unsatisfactory sample discovered is therefore reported to the Water Authority 24 hours before the official report is sent out. This is noted on the remarks column of the final report. Should a number of samples prove to be below standard from the same district the Water Authority can at once tell which filter bed or main requires attention.

The standard of purity reached by the Government tap water supplies is a very high one, B.C.C. being absent from 50 C.C. of water in 89.9 per cent of samples; absent from 10 C.C. in 8.1 per cent of samples and present in less quantities of water in only 20 per cent of samples. Even the most densely populated portions of the Chinese city enjoy a tap water of first class quality. The result is that, although Hongkong is situated in the tropics, the general health of the inhabitants reaches a high level.

### Chemical Analysis of Water

The following figures are taken from a very large number of reports made by the Government offices who make analysis systematically on the upland surface raw water in Hongkong and Kowloon.

The result of these chemical analysis vary greatly according to the rainfall, etc. Two sets of figures are therefore given; the first figures represent an approximate average of poor samples and the second figures are those for good samples.

All results are expressed as parts in a 100,000. They are as follows:—

Total solids from 11.8 to 3.6 parts. Chlorine as chlorides 1.27 to 0.67. Free ammonia 0.0137 to 0.0011. Albumenoid ammonia 0.0104 to 0.0011.

These figures show that the raw water supplies, from the storage reservoirs are of very good quality. That is to be expected when it is remembered that the rain water is collected from granite surfaces. For a great deal of the above information concerning the purity of water, etc., the author is indebted to Dr. E. P. Minett, M.D., who was until recently Government Bacteriologist in Hongkong.

### Insurance Companies Benefit

In recent years many Chinese have realized the great advantages of insurance of all types. It is surprising that the big insurance companies do not agitate, in a more organized manner, for efficient water supply. It is a guarantee of security. In the case of fire it is obvious that a plentiful supply of water must save great loss of property. That must relieve fire insurance companies of considerable expenditure and in the end benefit owners of property by reducing insurance rates. But a pure water supply also aids the companies interested in life insurance by extending the average span of life. Therefore insurance companies should interest themselves in this subject of water supply in China, where life insurance business is rapidly developing. It is indeed a subject that is of paramount importance to all of us.

"Public-health is purchasable, within natural limitations a community can determine its own death rate." Those words of Dr. Biggs have been proved to be true over and over again.

### Dr. Hu Shih's Demands

Edwin Chadwick was the great pioneer of public health and pure water supplies. He proved the close connection between filth and disease. As water supplies were improved and age-long accumulations of dirt and filth were cleared away, horrible plagues such as the cholera and typhus of earlier days, in Europe and other places, gradually disappeared. They must disappear, too, in China.

It could be done to-day—it will come to the China to-morrow. Hongkong offers an object lesson in efforts made for public health and especially in this matter of water supply. In quite recent years Canton has tackled the problem. All over China, in all of the existing cities, and the new ones that will grow out of the small towns and villages of to-day, pure water is a vital necessity, and efforts must be made to provide it.

There are the new prophets of humanity to be found in China to-day. As he goes about the country, seeing appalling poverty near to undeveloped resources, death and disease due to impure water and no sanitation, Dr. Hu Shih turns upside down the old ideas about East and West and vigorously demands the applications of science and the use of modern knowledge, for the lifting of the burden carried by the mass of his own people.

The second National conference on civil affairs, Nanking, 1932, deliberated on proposals submitted by numerous organizations, national, provincial and local and concerned with public health. They resolved that every province, municipality and hsien should undertake expenditure on public health. It is to be hoped they will tackle the problems of water supply in the immediate future.

This contribution completes the story of the water supplies of Hongkong and Kowloon as they exist to-day. No details have been given of the great work which is being carried out in the Shing Mun Valley where a reservoir that will hold 3,000 million gallons is being constructed.

The work of building the huge dam 300 feet high at Shing Mun will take about four years. It is a structure of most original design. It has attracted the attention of a large number of visitors, including Chinese officials from Kwangtung province. It will be an object lesson of how a large volume of water (such as may be needed for irrigation, water power developments or city water supply) can be stored.

The next contribution will discuss in detail this extensive engineering work at Shing Mun.

## Aerodromes for Malaya

THE *Times of Malaya* understands that the Public Works Department have completed detailed survey work of the aerodrome for Ipoh on the Gopeng Road and work will be commenced as soon as funds are made available. It is generally anticipated that provision for preliminary work will be made in the Perak 1935 Budget, so that work should be well under way by the end of next year.

Confirming the recent report that it is proposed to create a chain of aerodromes throughout Malaya, Group-Captain S. W. Smith, officer Commanding R.A.F., Far East, in his first public announcement revealed plans in an interview in Singapore for making Malaya the most active aerial center in the Colonial Empire.

He pointed out that Malaya is, both from the strategic and commercial points of view, of the utmost value to Great Britain in the air sense. Aerodromes have been established, or are contemplated, all the way from Alor Star to Singapore, including Sungei Patani, Penang, Taiping, Ipoh, Kuala Lumpur, Sitiawan, Port Swettenham, Sungei Nipoh, Batu Pahat and Malacca. The establishment of suitable landing grounds has created an entirely new engineering problem on account of the swampy nature of the ground.

Group-Captain Smith pointed out that the "chain" naturally followed the Imperial route down the West Coast. It was advisable that planes crossing Malaya should keep to the coast and away from the mists and rains of the mountain range.

The first purpose of an internal Malayan service naturally would be to act as a "feeder" line to the Imperial route, and, further it was on the West side of Malaya that the big cities of the Peninsula were situated.

This did not preclude the possibility of less pretentious landing grounds being established by State Governments wherever they wished and, indeed, it was doubtful whether airway companies would be attracted by the possibilities of an internal Malayan service until far more of the Peninsula was dotted with aerodromes than was at present the case.

In Group-Captain Smith's opinion the first people to seize the opportunity to establish an inter-Malay service will be more than amply repaid for their foresight. A seaplane service up and down the West coast would not be an economical proposition. Land-planes were far less expensive to maintain.

Marine services only began to pay when machines with a huge pay-load were used. These were of a type which would no doubt ultimately be used on the Imperial route as this was speeded up, and more ocean crossings were made.

Group-Captain Smith made a quick survey of the merits of Malaya's landing grounds.

The intention was, he revealed, to establish good aerodromes every 50 miles or so down the Peninsula.

Alor Star and Sungei Patani were fit to receive all classes of aircraft. Penang was still a problem owing to the soft nature of the ground but additional hard runways were being laid down and he attached so much importance to Penang that he felt no effort should be spared to make the aerodrome there a good one, and as soon as possible.

Taiping could boast already one of the best aerodromes in the country. The cost of maintenance was practically negligible. Ipoh must not be forgotten. The distance between Taiping and Kuala Lumpur was 150 miles and it was imperative that other landing grounds should be established. A site had been chosen at Sitiawan.

Swampy ground, undermined by millions of crabs, made Port Swettenham their hardest nut to crack. After three years work the site chosen there was still unserviceable. It would take another three years before it would be ready to receive loads of 10 to 15 tons. He had accordingly recommended that the Kuala Lumpur aerodrome be conditioned with all possible speed. "The Kuala Lumpur aerodrome is not ideally situated," remarked Group-Captain Smith. "Mists are troublesome. Kuala Lumpur cannot be left out of the chain, however, and unquestionably another site a few miles to the west of the city will have to be chosen later."

## Kuznetsk—Second Coal Center of the U.S.S.R.

**A**MONG the industrial tasks of great economic significance to be carried out under Russia's second five year plan is the conversion of the Kuznetsk coal basin (in Siberia) into a second Donetz Basin, or, so to increase the production of Kuznetsk coal as to be sufficient to meet the industrial needs of the Urals and Siberia, particularly the needs of the giant metallurgical works which have been built at Magnitogorsk and Stalin.

In geological deposits the Kuznetsk coal basin is the richest not only in the Soviet Union but in Europe. Its deposits of coal, concentrated on an area of 16,000 sq. kilometers, are estimated at hundreds of milliards of tons. The Kuznetsk basin contains about 90 per cent of the useful minerals of the Soviet East, also various valuable kinds of coking coal. This immense basin before the revolution was practically not exploited. For one thing, it was very remote from the industrial centers, and for another, the colonization policy of the old regime was against the industrialization of outlying territories and national minority regions. Even the application of foreign capital in the Kuznetsk Basin (in 1913) did not materially change the position; the two share capital companies then created were not strong enough to construct a metallurgical works of 325,000 tons capacity on the basis of Kuznetsk coal.

The development of the Kuznetsk coal basin only commenced at the end of the civil war. In the early years, the production of coal increased slowly. Nevertheless, on the eve of the first five year plan the output reached 2,200,000 tons, i.e., three times the output of 1913. Wide prospects for the increased production of coal in the Kuznetsk Basin were opened up by the first five year plan, when numerous new mines were constructed, new industrial enterprises, houses and municipal and cultural amenities. During the first five year plan a sum of 320 million roubles was expended on capital construction in the Kuznetsk Basin. The amount so expended in the first year of the second five year plan was 145 million roubles. Moreover, the greater part of the total capital expenditure (410 million roubles) has been incurred in the last three years.

During these three years many new mines have been sunk in the Kuznetsk Basin. Whereas in 1930 the Kuznetsk Basin had 14 mines of a capacity of 4.6 million tons, at the beginning of 1934 it had 37 units with an estimated output capacity of 15 million tons. During 1933 alone nine units were put into operation with a capacity of 6.4 million tons. The small mines of the Kuznetsk Basin have given place to giant new mines such as the "Koksovaya," having an output capacity of three million tons.

Much progress has been made in the last few years in the mechanization of coal raising in the Kuznetsk Basin. Attempts to mechanize the mines of Kuznetsk were first made in 1927-28 and in that year the proportion of the total coal produced by mechanized methods was 1.8 per cent. By 1930 it had increased to 22.4 per cent and by 1933 to 53.2 per cent. In the next few years the rate of mechanization in coal raising will be considerably speeded up as a

result of the completion in 1934 and 1935 of two new works for the manufacture of mining equipment in Novosibirsk and Kiselevsk.

In addition to increasing mechanization, there has also been a growth in the power supply of the Kuznetsk Basin the last few years. The generating capacity of the electric power stations attached to the mines during the period 1931-33 has been doubled. Many mines are already receiving (and the remainder will be doing so in the present year) their supply of electric energy from big regional power stations—the Stalinsk of 60,000 kwt. capacity and the Kimerovsk of 48,000 kwt. capacity. Both these stations are connected up by high voltage transmission lines over a distance of 200 kilometers and a tension of 110,000-volts.

The effect on the output of coal in the Kuznetsk Basin resulting from the construction of new mines, increased mechanization of processes and supply of electric energy may be seen from the following figures: In 1930 the output was 3.6 million tons; 1931, 5.2 million tons; 1932, seven million tons; 1933, 9.2 million tons.

As compared with 1930 the coal output of 1933 had increased by over 2½ times, and as compared with 1927-28 by almost four times. The new mines have had a considerable influence on the increase in output. Whereas in 1930 90 per cent of the total coal produced at Kuznetsk came from the old mines, in 1933 the old mines accounted only for 20 per cent of the total output, four-fifths of the entire output of that year coming from the new mines.

Side by side with the growth in the output of coal as a whole, there has been a corresponding growth in the output of coking coal. In 1931 1.5 million tons of coking coal was raised and in 1933 three million tons.

Mention must also be made of the improved transport facilities in the Kuznetsk Basin. In 1930 the Kuznetsk mines possessed 58 kilometers of railways of wide gauge; at the beginning of 1934 their length was 220 kilometers. In addition to new construction, there has been a considerable reconstruction of railways which has made it possible to use heavier rolling stock.

Lastly, much work has been carried out in the Kuznetsk Basin during the last few years in the building of houses for the workers and engineers employed in the mines and also on various municipal enterprises and amenities. During the last three years a sum of 146 million roubles has been expended on these purposes.

For 1934 it has been planned to increase the production of Kuznetsk coal to 12 million tons, which is to include five million tons of coking coal. In the last year of the second five year plan (1937) the output of Kuznetsk coal is planned to reach 20.5 million tons, 40 per cent of which must be coking coal. During the remaining period of the second five year plan a number of big new mines are to be put into operation, equipped with the most modern equipment. These are expected to transform the Kuznetsk coal basin into a second coal base, equal to that of the Donetz Basin.—*The Mining Journal*.

### Chinese Wireless Stations

As the result of the need of greater communication facilities in China, a large order for wireless stations has been awarded to Standard Telephones and Cables, Ltd., by the Chinese Government. Under the scheme that is being put in hand the larger towns in China will have their own transmitting and receiving stations in order that they may be in constant communication by telephone or telegraph with other large and important centers. The wireless links will take the place of costly toll lines for connecting the local telephone networks together. Although the scheme will be on a smaller scale than others, it will be almost identical with the world telephone services between England, America, Africa, Australia, etc., with which Standard Telephones and Cables, Ltd., have been associated. The apparatus will, however, incorporate new features, and careful precautions will be taken to ensure absolute secrecy on the telephone side. Facilities will also be provided for high-speed telegraphy.—*The Engineer*.

### Manchurian Coal Industry

In connection with the comprehensive schemes for the economic development of Manchuria by a group of Japanese and Manchurian trusts, a plan has also been worked out for the merging of the Manchurian coal industry. The Japan-Manchuria Coal Company is to be formed, with a capital of Y.16,000,000 divided among Japanese financiers and the Manchurian Government. Neither the Fushan collieries of the South Manchurian Railways nor the Pushihu collieries of the Japanese Okura concern are, however, to be transferred to the new trust. The collieries which will be taken over and developed during the next few years have the following coal reserves:—Kuolikang, 400,000,000 tons; Peipiao, 250,000,000 tons; Sian, 100,000,000 tons; Fuchou, 36,000,000 tons; Pataokau, 20,000,000 tons; and Hsingkang, 120,000,000 tons. The output of the new concern in the first year is estimated at 2,000,000 tons, as compared with 7,700,000 tons of the Fushan collieries.—*Iron and Coal Trades Review*.

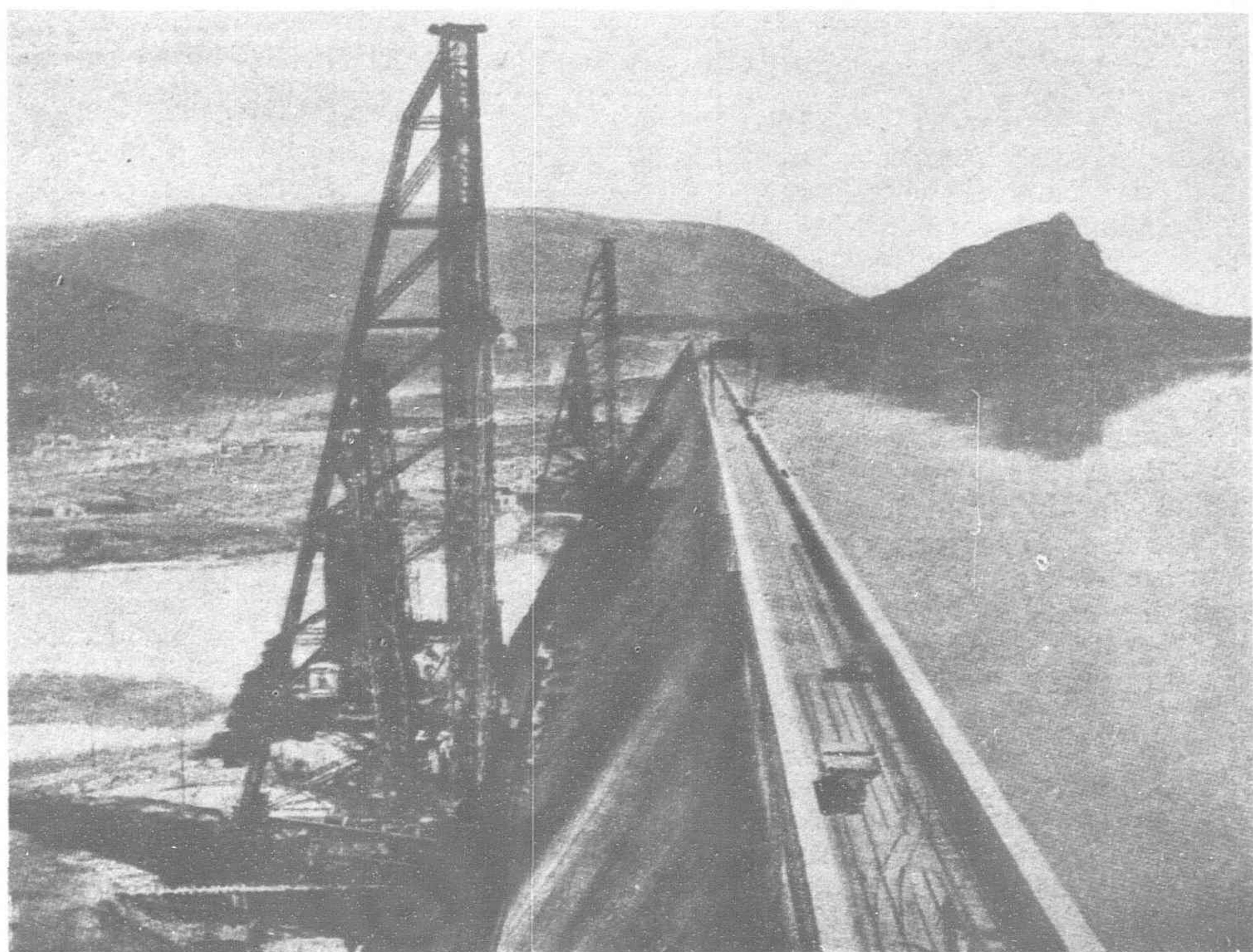
# The Cauvery-Mettur Reservoir Project in South India\*

**A**MONG the great engineering works constructed during the last decade must be numbered the Cauvery-Mettur Reservoir Project, in the Madras Presidency of Southern India, which was officially opened by Sir George Stanley, Governor of Madras, on Tuesday, August 21.

Mettur, which until a few years ago was only a small, almost unheard of village, is situated on the Cauvery River at a point about  $11^{\circ} 48'$  latitude, and  $77^{\circ} 48'$  longitude, where the river flows practically north and south. It lies about 36 miles north of the railway junction at Erode on the South Indian Railway, and 25 miles west of Salem Junction on the same railway.

Several of the large rivers of India rise in the Western Ghats, wind their way across practically the whole breadth of the peninsula from west to east, and discharge into the Bay of Bengal. The Cauvery River, which is the southernmost of these has its source in the Coorg District. As it nears the eastern coast the river bifurcates, and the northern and principal channel thence is known as the Coleroon. The Southern branch retains the name of the Cauvery and finds its way into the sea through numerous channels running through a vast delta.

There is ample proof that irrigation of the Cauvery Delta was practised from the earliest times, but the position when the East India Company took over the Tanjore District in 1801 was that the channels were rapidly silting up, and large areas of land were left uncultivated from lack of water. In 1836 the construction of the Upper Anicut, upstream of the bifurcation of the Cauvery and the Coleroon, greatly relieved the difficulties of water supply; in fact, this construction proved so effective that it was found necessary to build a grade wall across the river in order to curtail the supply and prevent damage by erosion. Though the improvement and development in the control of the water and floods of the river have resulted in considerably increased land values and assessments, and in natural consequence the improvement of the general welfare of the people, it has always been realized that the supply to the Delta was capable of further improvement, such improvement depending on storage. A dam across the Cauvery at a suitable spot to store up excess water during the monsoon, and to pass it down later when required for irrigation, was the obvious solution, but the decision to build this dam at Mettur was only made after long controversy and arbitration with the Mysore State Government.



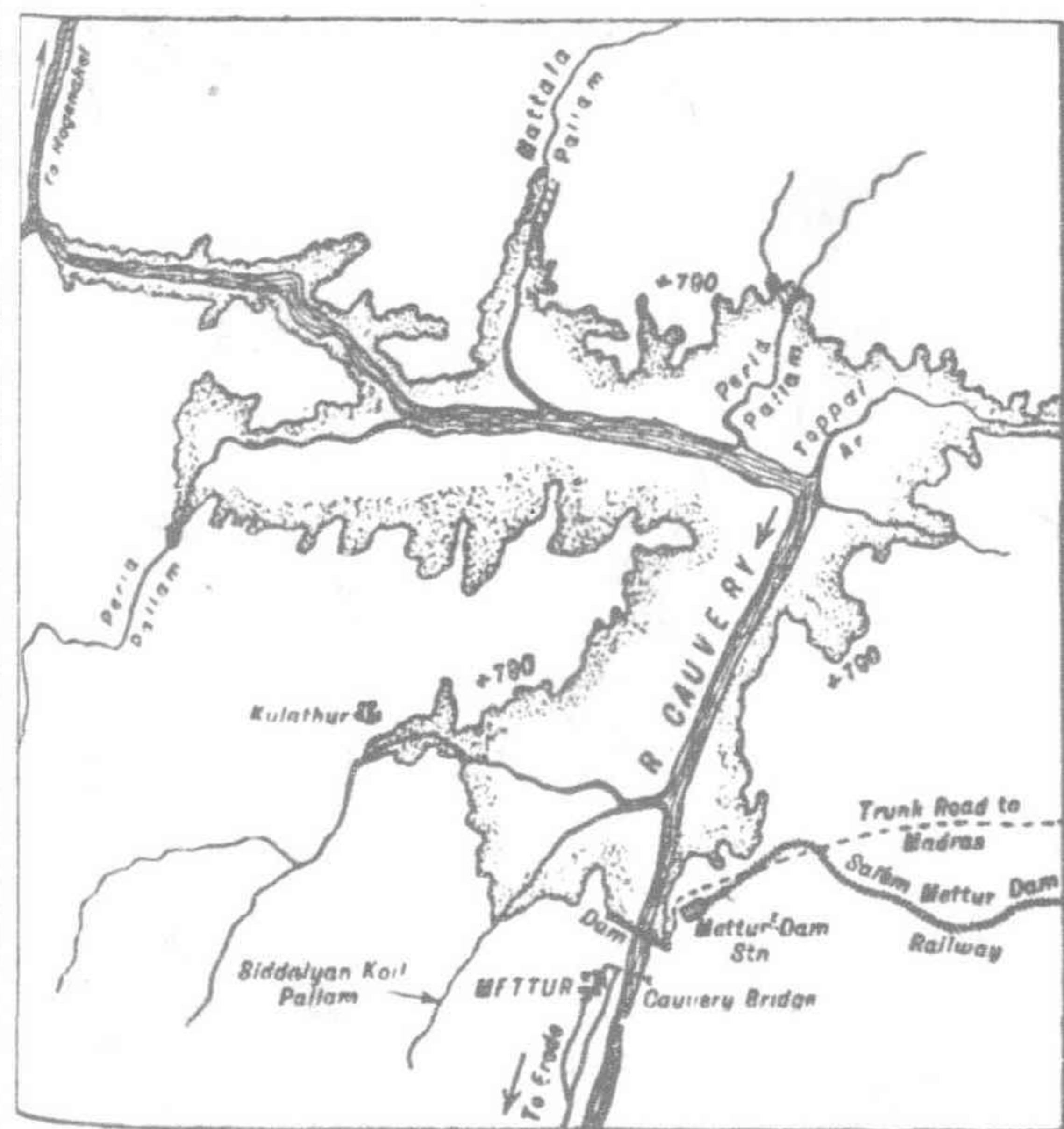
Completed Dam and Concreting Towers

pared in 1910 by Colonel W. M. Ellis, R.E., Special Superintending Engineer (late Chief Engineer, P.W.D.), forms the basis of the work actually being executed. The present scheme was sanctioned by the Secretary of State for India in 1925, and the designs for an all-concrete dam were undertaken by Mr. C. T. Mullings, C.S.I., Chief Engineer of the Madras Presidency, upon whom a knighthood has now been conferred. The site originally chosen by Colonel Ellis is about a mile downstream of that which has ultimately been selected as shown by a line engraving on this page. Mr. D. G. Harris, C.I.E., officiating Consulting Engineer to the Government of India, to whom the project was referred, in a note commenting upon this subject, stated that the main consideration which led to the proposal to change the site was not geographical, but the fact that in 1924 the Cauvery River discharged a flood nearly twice as great as any previously experienced. The result of seventy years' gaugings had given the maximum flood discharge of the river as 250,000 cusecs; the discharge at that of 1924 was computed at no less than 470,000 cusecs. The difficulty of dealing with such a volume of surplus water at the lower original

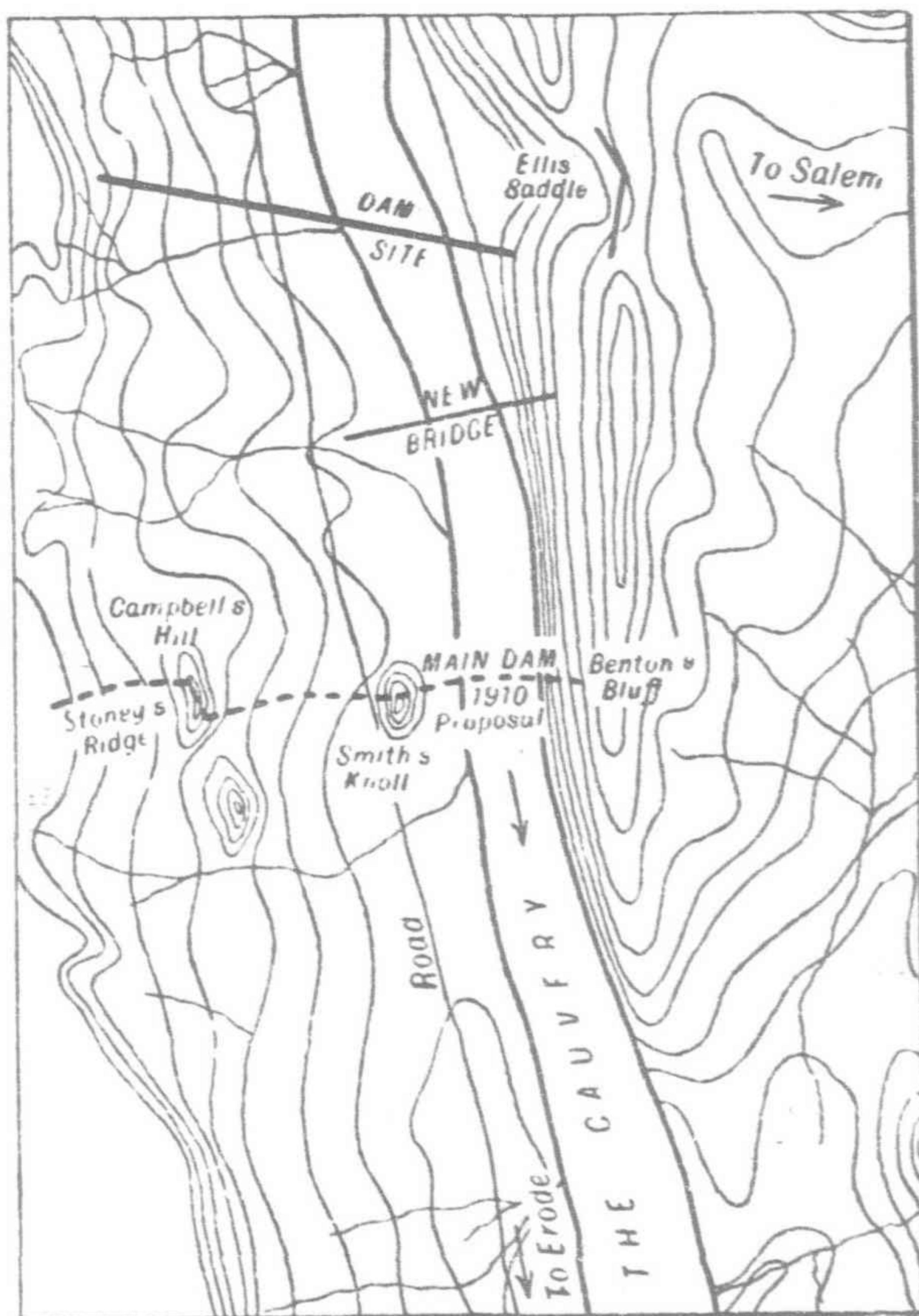
The idea of placing a dam across the river in the neighborhood of Mettur is an old one, the origin of which is difficult to locate, but the scheme pre-

pared in 1910 by Colonel W. M. Ellis, R.E., Special Superintending Engineer (late Chief Engineer, P.W.D.), forms the basis of the work actually being executed. The present scheme was sanctioned by the Secretary of State for India in 1925, and the designs for an all-concrete dam were undertaken by Mr. C. T. Mullings, C.S.I., Chief Engineer of the Madras Presidency, upon whom a knighthood has now been conferred. The site originally chosen by Colonel Ellis is about a mile downstream of that which has ultimately been selected as shown by a line engraving on this page. Mr. D. G. Harris, C.I.E., officiating Consulting Engineer to the Government of India, to whom the project was referred, in a note commenting upon this subject, stated that the main consideration which led to the proposal to change the site was not geographical, but the fact that in 1924 the Cauvery River discharged a flood nearly twice as great as any previously experienced. The result of seventy years' gaugings had given the maximum flood discharge of the river as 250,000 cusecs; the discharge at that of 1924 was computed at no less than 470,000 cusecs. The difficulty of dealing with such a volume of surplus water at the lower original

\* The Engineer



Mettur Dam and Reservoir



Proposal of 1910 and Actual Site chosen for Mettur Dam

site was almost insuperable. In the project sanctioned, the surplus flood water is to be escaped over the saddle known as the Ellis saddle, a little upstream of the dam on the left bank of the reservoir. This saddle is provided with a regulating bridge, fitted with adjustable gates, designed to pass about 250,000 cusecs. The site finally selected was considered by Mr. Harris as ideal for an escape of the surplus water, which will flow down an easy gradient behind the hill which forms the left bank of the river, rejoining the main stream about two miles lower down, thus obviating any possible scour near the dam site, and the consequent expensive protection which would have been necessary at the toe of the dam.

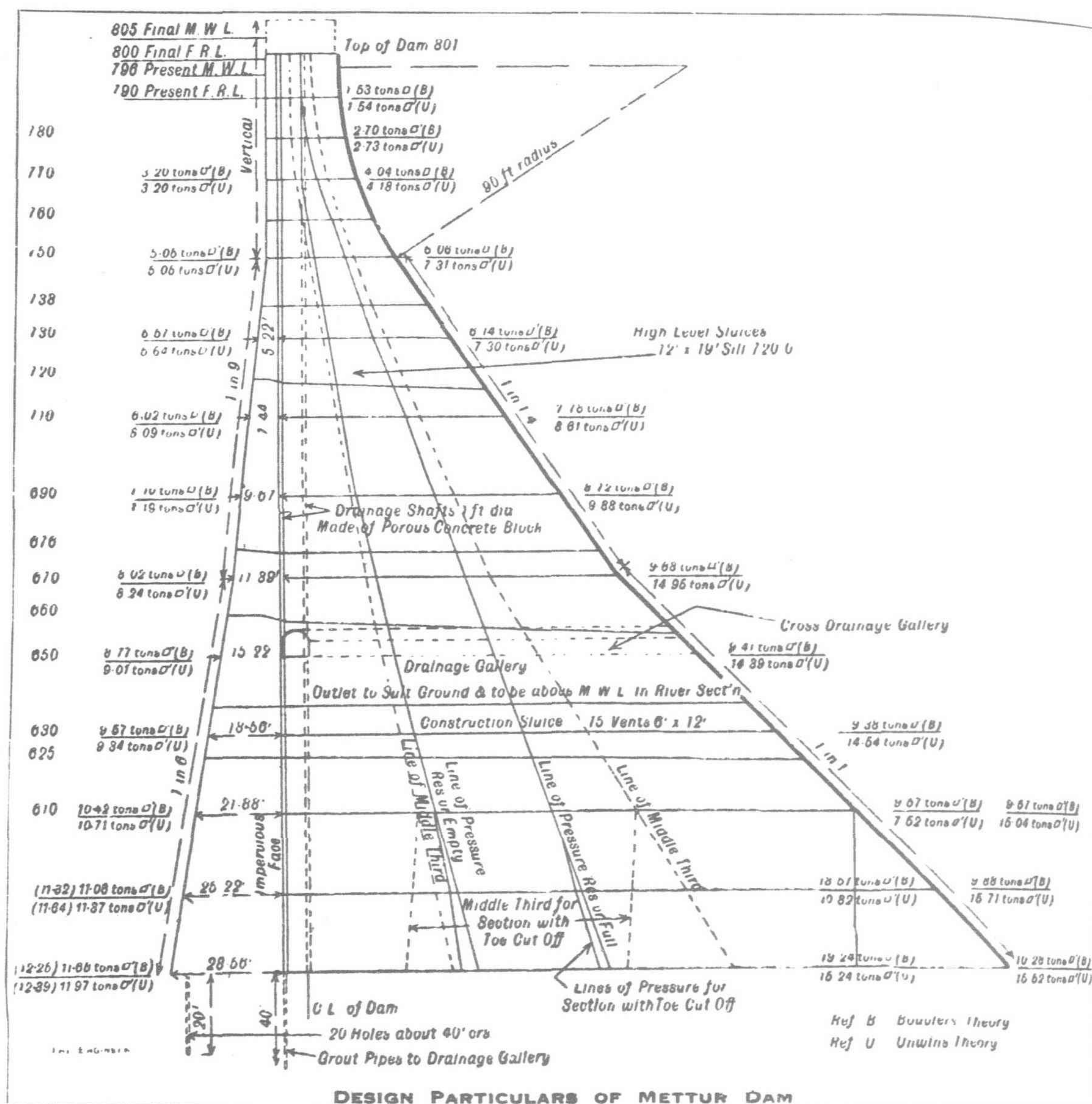
The first engineers appeared on the ground at Mettur in 1926, and from that time until to-day work has progressed steadily. A large camp was built to accommodate the great number of people to be employed (this number reached about 14,000), and contained magisterial and police buildings, offices, a hospital, a health laboratory, a filtered and chlorinated water supply, drainage system, and electric light. Nearly 50 miles of new and bridged roads had to be constructed suitable for heavy lorry traffic, and what were once simple village roads were turned into first class highways. A special railway from the town of Salem, 25 miles away, was built, and about 50 miles of 2-ft. gauge tramway equipped with 26 locomotives and 1,000 wagons, to transport materials. The engineering buildings include a workshop, a locomotive repairshop, and several store sheds, besides a power house with a connected load of 6,000 h.p. Power was obtained from Sivasamudram by means of a 62 mile transmission line. Power was paid for on a sliding scale, but when the works were in full swing about 0.55 annas per unit was being paid.

Briefly, it may be said that the dam, now almost completed, is designed to serve a threefold purpose:

- (1) To impound the flood water during the S.W. monsoon, thus making possible a regulated supply during the rest of the year.
- (2) To serve as a flood moderator, so preventing damage to the country south of the reservoir.
- (3) To utilize the head of water induced in the lake for hydro-electric purposes, the estimated supply being 10,000 h.p. continuously.

Large areas are being brought under irrigation in the Tanjore district by means of a regulator just above the existing Grand Anicut and a system of canals. The extent of the new irrigation is 301,000 acres of single crop, and some 100,000 acres of double crop. In addition, the reservoir ensures a better supply to 1,000,000 acres of old irrigation.

The original scheme and estimates proposed that the dam, like many others in India, should be constructed in rough stone masonry laid in lime mortar, but it was soon realized that these methods were too slow, and that the date for completion would be many years ahead. It was, therefore, decided to build the whole dam entirely in Portland cement concrete, first class Portland cement, manufactured in the country, being available, a decision that had to be slightly modified as work progressed, as will be explained later.



### Main Dimensions of Dam

The extent of the reservoir created by this dam is shown by one of the engravings. It measures about 59½ square miles in area and has an estimated capacity of about 93,500 million cubic feet. The site selected for the dam necessitated the main structure being practically one mile long with a maximum height above the foundation of 340-ft. The total cubic contents of the dam are 54 million cubic feet. The general form of the cross section is shown in accompanying drawings and design particulars in another line engraving.

The total estimated cost of the whole project was in the neighborhood of Rs. 8 crores (equivalent to £6 million sterling), of which about Rs. 5.09 crores represent the cost of the dam (say, £3,800,000).

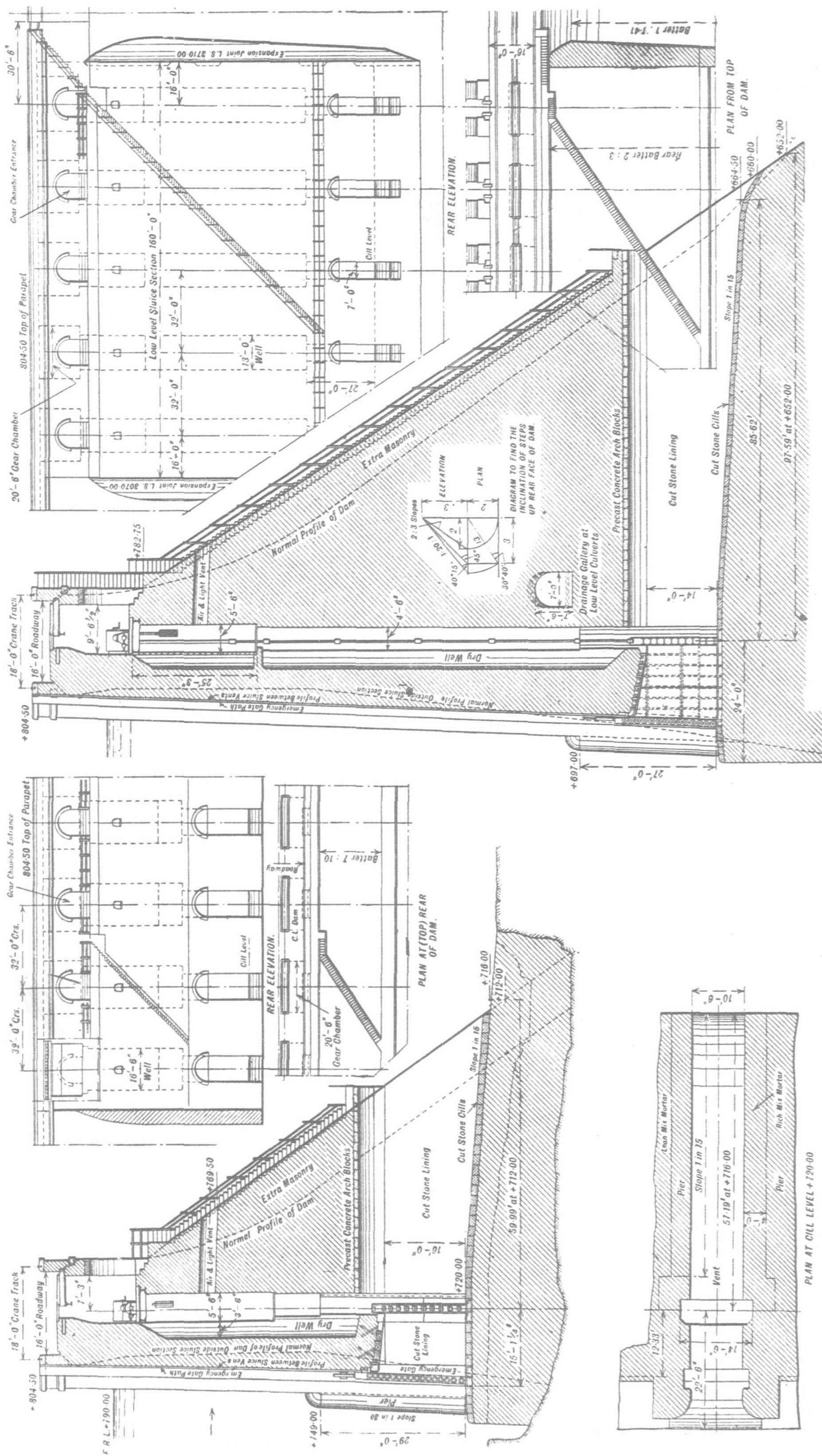
### Labor

Labor was cheap, and although the inhabitants of the immediate neighborhood were few and scattered, men and women, and whole families, soon began to flock to the site and take up their quarters in the new and specially prepared camps. The wages paid were based on seven annas a day for a coolie working 8½ hours. Except during an occasion of an outbreak of cholera, when labor decamped, there was no difficulty in obtaining the quantity required. A locomotive driver on one of the small Sentinel engines was paid from Rs. 1-8 to Rs. 2-8 a day.

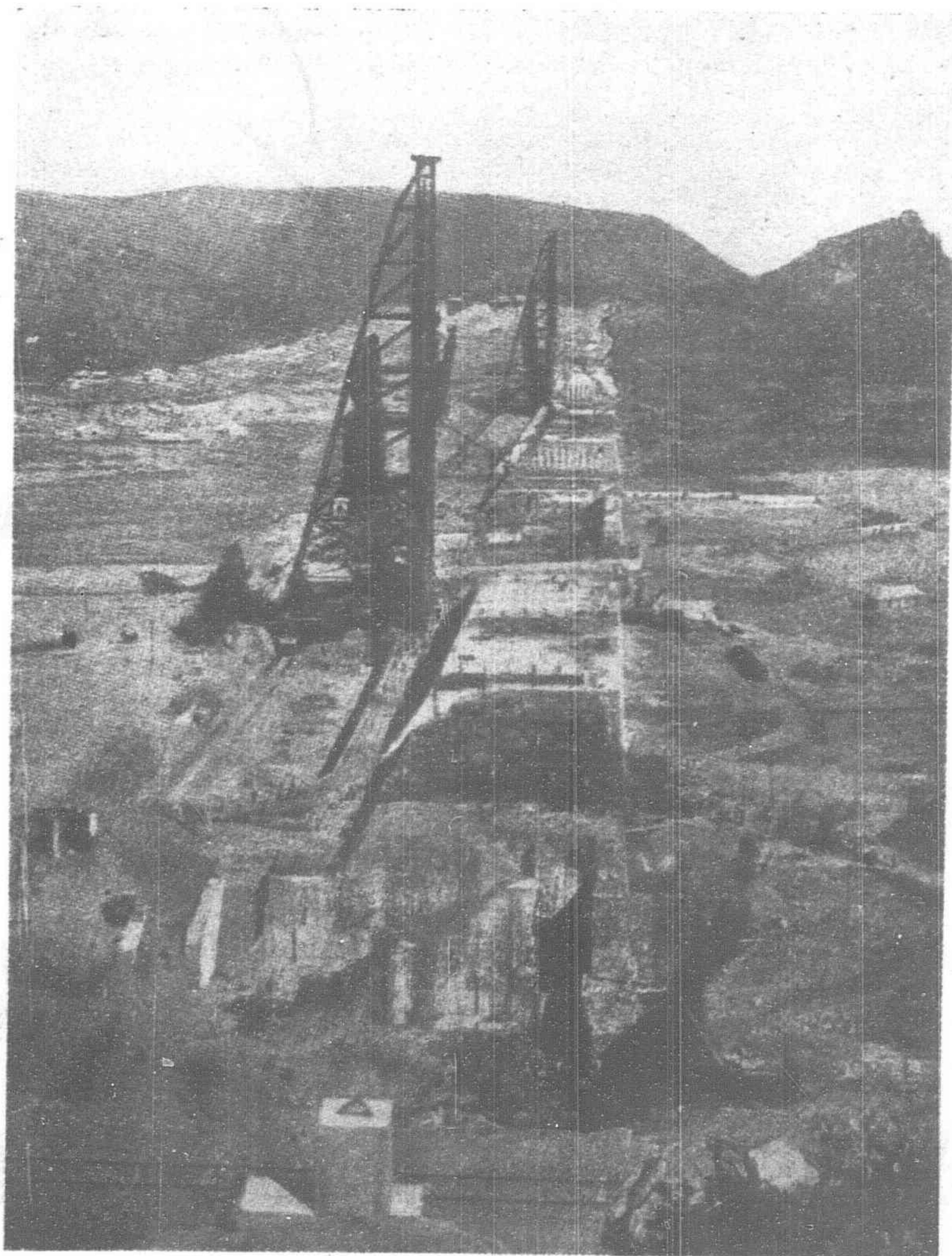
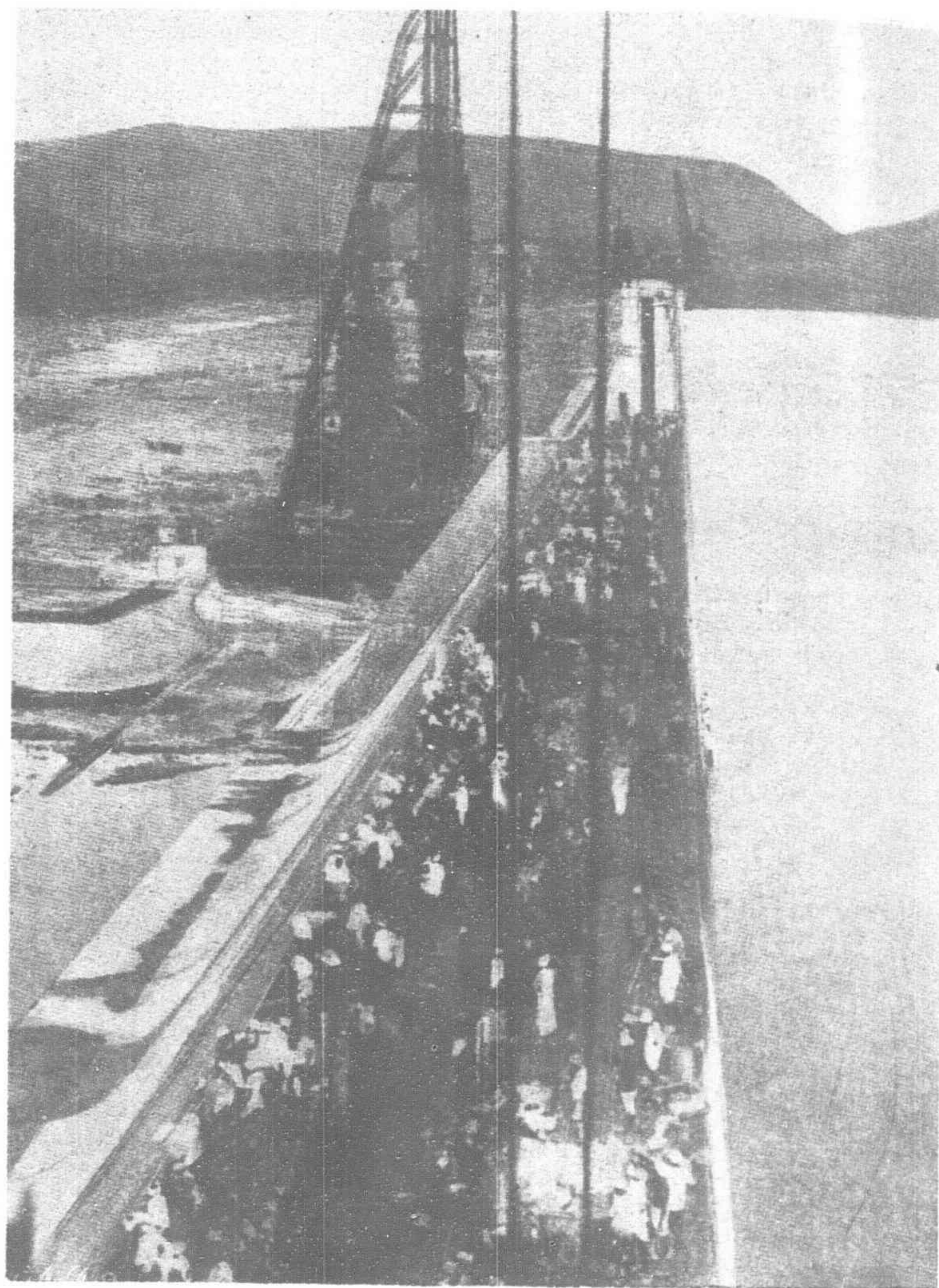
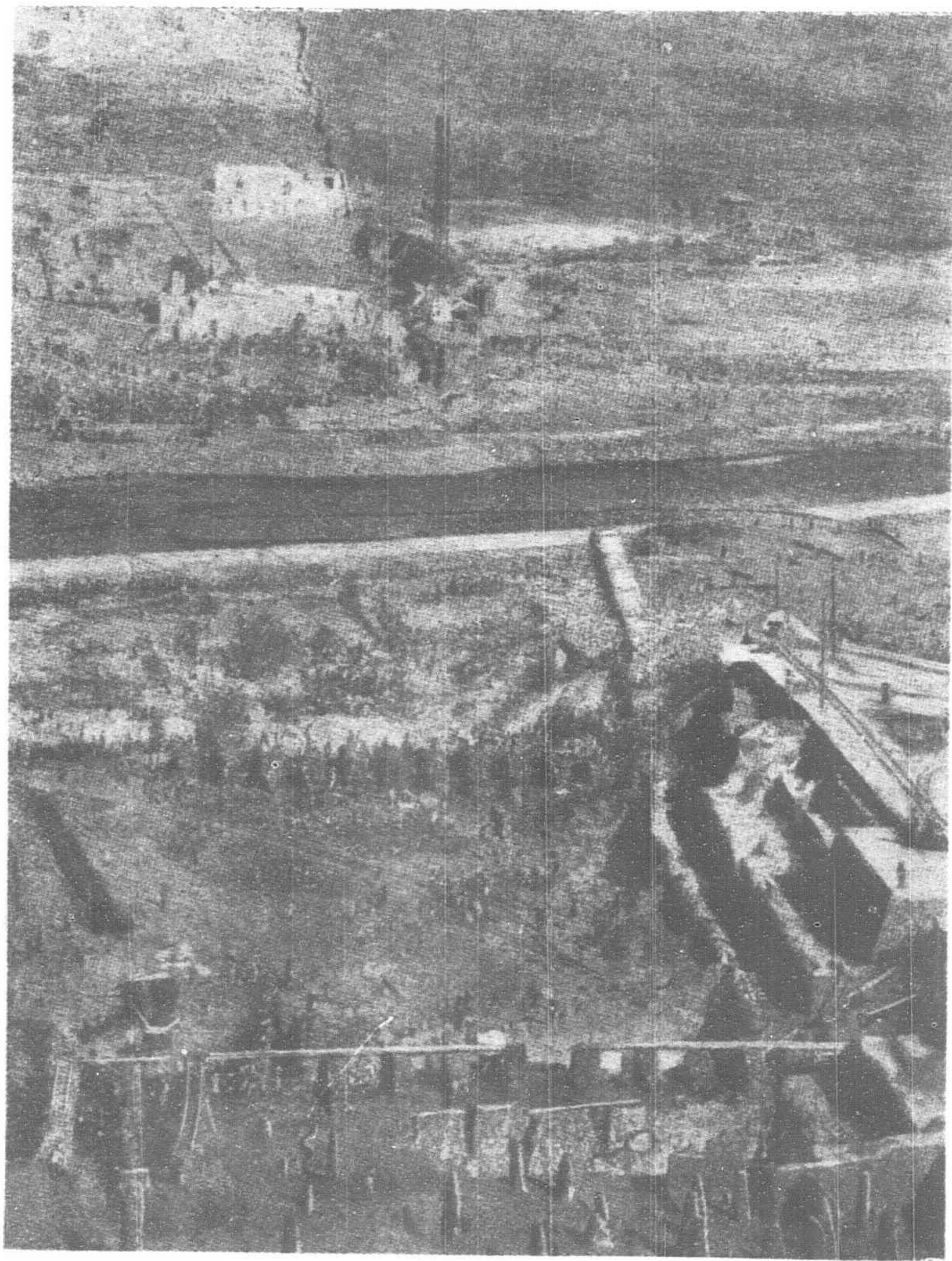
### Foundations

The foundations are on charnockite rock, a hard stone similar to Aberdeen granite. There is a good variety of this rock right across the valley at the site of the dam, exposed in some parts of the river bed, and from 5-ft. to 70-ft. below ground elsewhere. It is interesting to note that the entire excavation necessary was

The sand was obtained from the river bed itself and was of the very best variety suitable for concrete work. It was, naturally,



# Details of Design of Cauvery-Mettur Dam at High and Low Level Sluices



Views from the Eastern End of the Cauvery-Mettur Dam showing various stages in its construction

clean and well graded, tested specimens showing average voids as only 31 per cent.

The whole of the cement for the work was manufactured in India and was Char-Minar brand, supplied by the Shahabad Cement Company, Ltd., from their works at Shahabad, in Hyderabad State. At that time this works was the most southerly situated in India, and therefore by far the nearest to Mettur. Nevertheless, the railway lead was somewhere about 500 miles in length, a fact which necessarily added considerably to the cost of the cement. A contract was, however, satisfactorily arranged for the supply of about 180,000 tons at Rs. 53 per ton, delivered on site. A little over Rs. 24 a ton of this price represents freight. The whole of this cement was of a quality in excess of requirements of the current British Standard Specifications. The following are extracts from a typical test certificate of tests made at the Government Test House, Alipore, Calcutta, in 1931 on this brand of cement:—

"CHAR-MINAR" BRAND PORTLAND CEMENT

	Results obtained.	Standard (1925).
1. Fineness of grinding, per cent :		
Residue on mesh 180 by 180 ..	3.35	Not more than 10%
Residue on mesh 76 by 76 ..	0.02	Not more than 1%
2. Chemical composition, % Lime	65.24	
Silica .. .. .	22.02	
Alumina .. .. .	5.61	
Iron oxide .. .. .	2.09	
Magnesia .. .. .	1.74	Not more than 4%
Sulphur calculated as SO <sub>2</sub> ..	1.52	Not more than 2.75%
Total loss on ignition ..	0.77	Not more than 3.0%
Insoluble residue .. .. .	0.99	Not more than 1.5%
	99.94	
Net proportion of lime to silica and alumina .. .. .	2.71	Between 2.9 and 2.0
3. Tensile strength (neat) :		
7 days (average of six briquettes), lb. ..	844	Not less than 600 lb.
4. Tensile strength (cement and sand) :		
7 days (average of six briquettes), lb. (Ws) .. .. .	540	Not less than 325 lb.
		10,000
28 days (ditto) .. .. .	565	Ditto Ws + $\frac{10,000}{Ws}$
		= 559 lb.
5. Setting time :		
Initial .. .. .	128 min.	Not less than 30 min.
Final .. .. .	2 h. 58m.	
6. Soundness .. .. .	1 mm.	Not more than 10 mm.

Proportion of water used in gauging : (a) Neat briquettes, 23 per cent ; (b) cement and sand briquettes, 8½ per cent. Temperature during period of testing, 70 deg. Fah. to 81 deg. Fah.

Principally for reasons of economy, it was decided to add surki to the cement, so that 20 per cent of the cement proportion in each batch of concrete consisted of this material. The surki was manufactured on the site of the dam from local bricks, and ground in a special disintegrator to the following specification, not more than three per cent to be retained on a 50 by 50 square mesh and at least 60 per cent to pass through a 100 by 100 square mesh sieve. Tests showed that the resulting concrete would be amply strong enough, although the addition of the surki did tend

to retard the rate of hardening in the early stages. Many careful tests were made on the works at the well-equipped laboratory that was provided. Besides the usual machines and apparatus for testing cement, a 100 ton compression machine and a machine for testing permeability up to 211 lb. per square inch were installed. Careful records were kept, not only of the tests on the cement as it was received, but also on 6-in. concrete cubes taken directly from the works as the concrete was deposited. These cubes from the concrete used in the hearting of the dam showed a compressive strength of from 60 to 80 tons per square foot, and those from the richer concrete used in the dam facing showed a strength of from 90 to 95 tons per square foot in twenty-eight days. The cubes were matured for the whole time under water and tested wet. Calculations show that the maximum stress that the concrete will have to withstand is 10 tons per square foot.

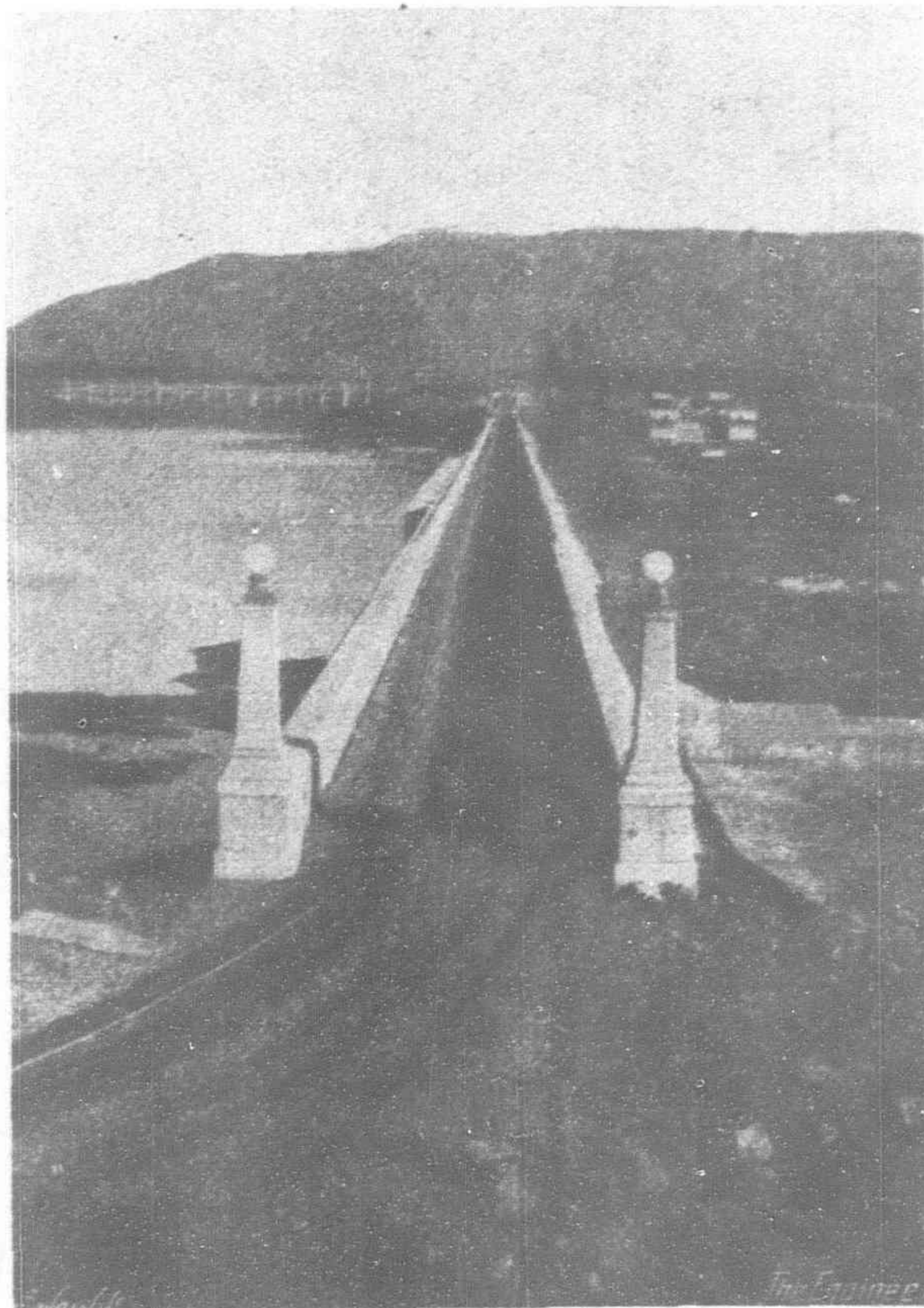
The proportions for the concrete were as follows:—

In the hearting of the dam .. .. .	1	{ 0.8 parts cement 0.2 parts surki 4 parts sand 8 parts broken stone
In the impervious face .. .. .	1	{ 0.8 parts cement 0.2 parts surki 2.75 parts sand 5 parts broken stone

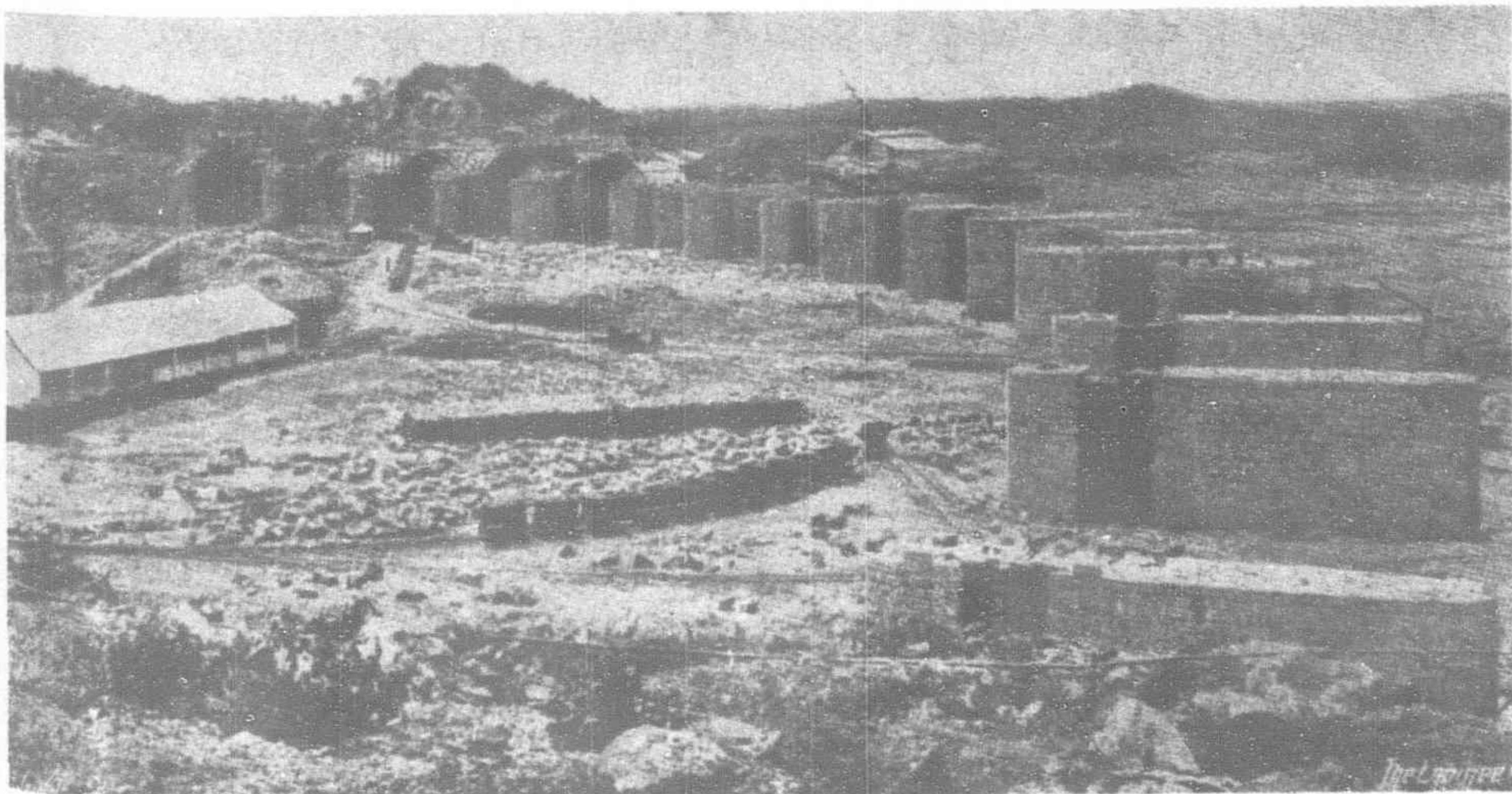
The thickness of the impervious face was to be 3-ft. at the top of the dam, increasing to about 25-ft. at the bottom.

The water for the concrete was also carefully gauged to 16 gallons to 2.4 cubic feet of cement, i.e., eight gallons per bag. For the purpose of proportioning the mixes the cement was taken as weighing 94 lb. per cubic foot, and all measurements of cement were made by weight. The surki was not added to the cement until all the materials were put into the mixer.

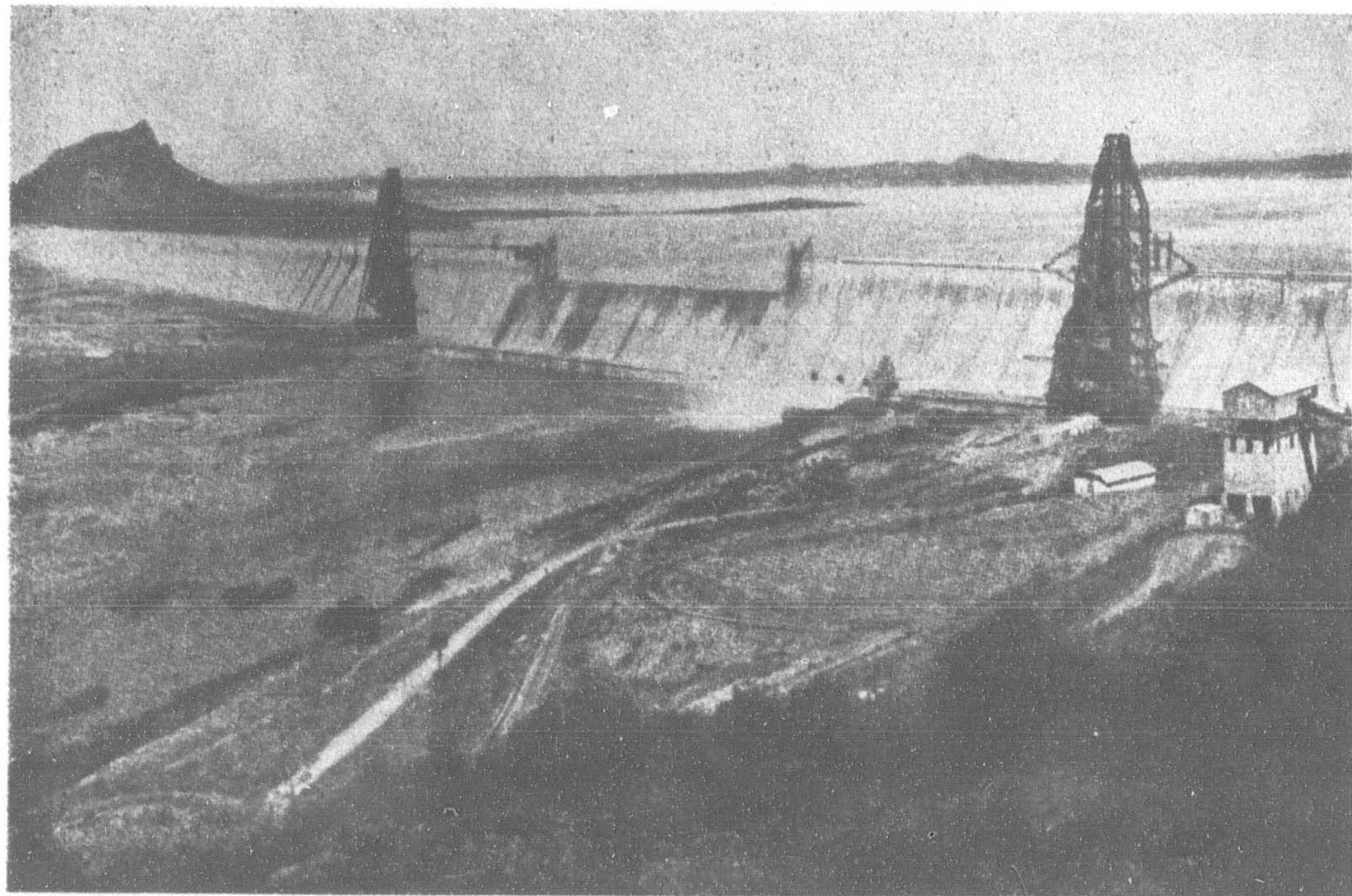
The depositing of the large masses of concrete with the requisite speed presented an interesting problem, and it was ultimately decided to install two large mobile distributing towers. These were designed and manufactured by Stothert and Pitt, Ltd., of Bath. They stand 286-ft. high above the front rail which carries them, and 304-ft. above the rear rail. They were designed for an output of 166 tons of cement per hour, or 2,000 tons per twelve-hour day, and each weighs about 1,400 tons. The shoots have a range of 126-ft. of the dam, without moving the towers. Their cost was £132,000 f.o.b. London. Some trouble arose in the use of these towers, owing to the difficulty of feeding them with materials fast enough for them to work at their maximum capacity. In actual working it was found that the average outturn for a day



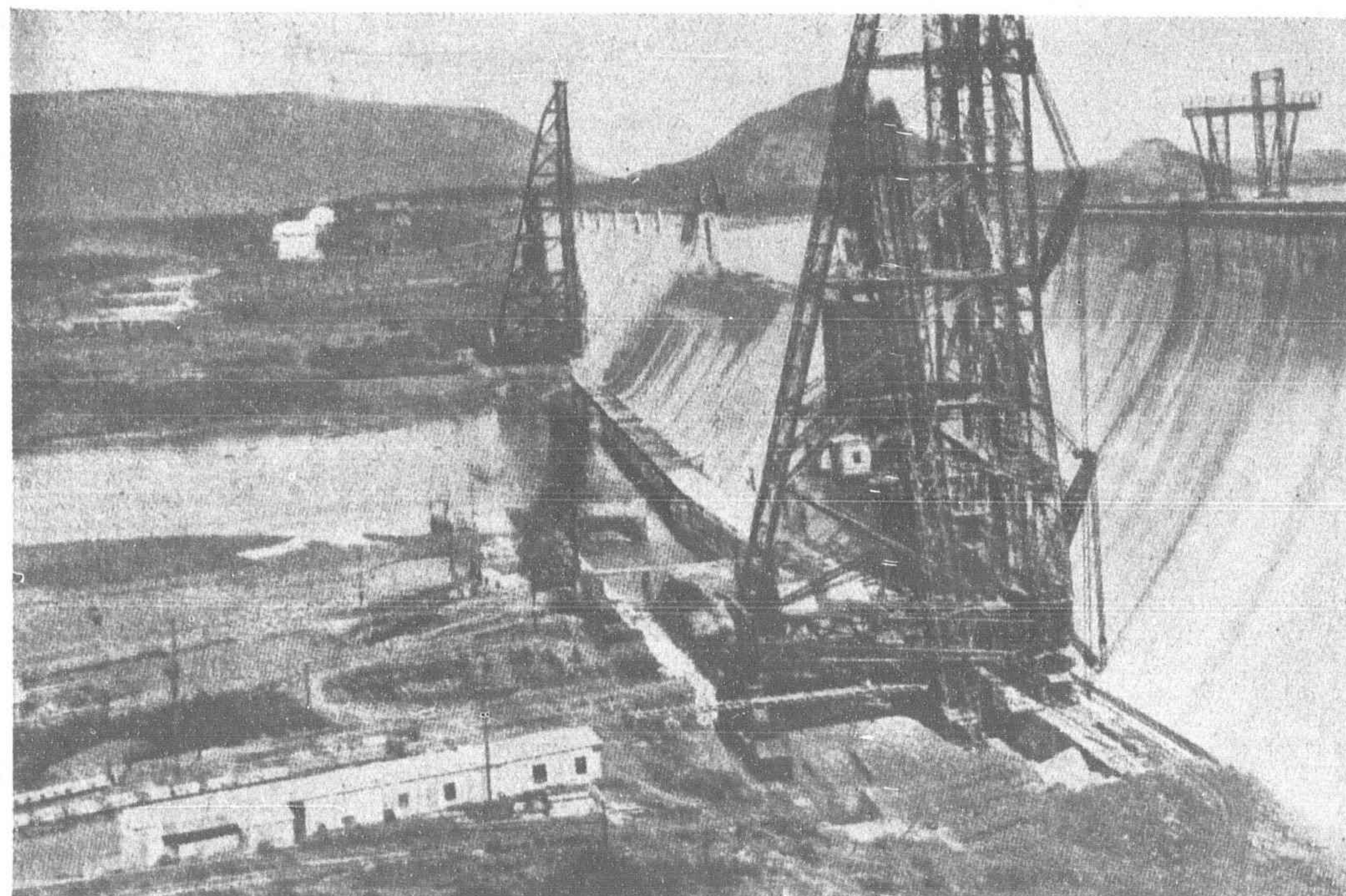
Dam and Surplus Works



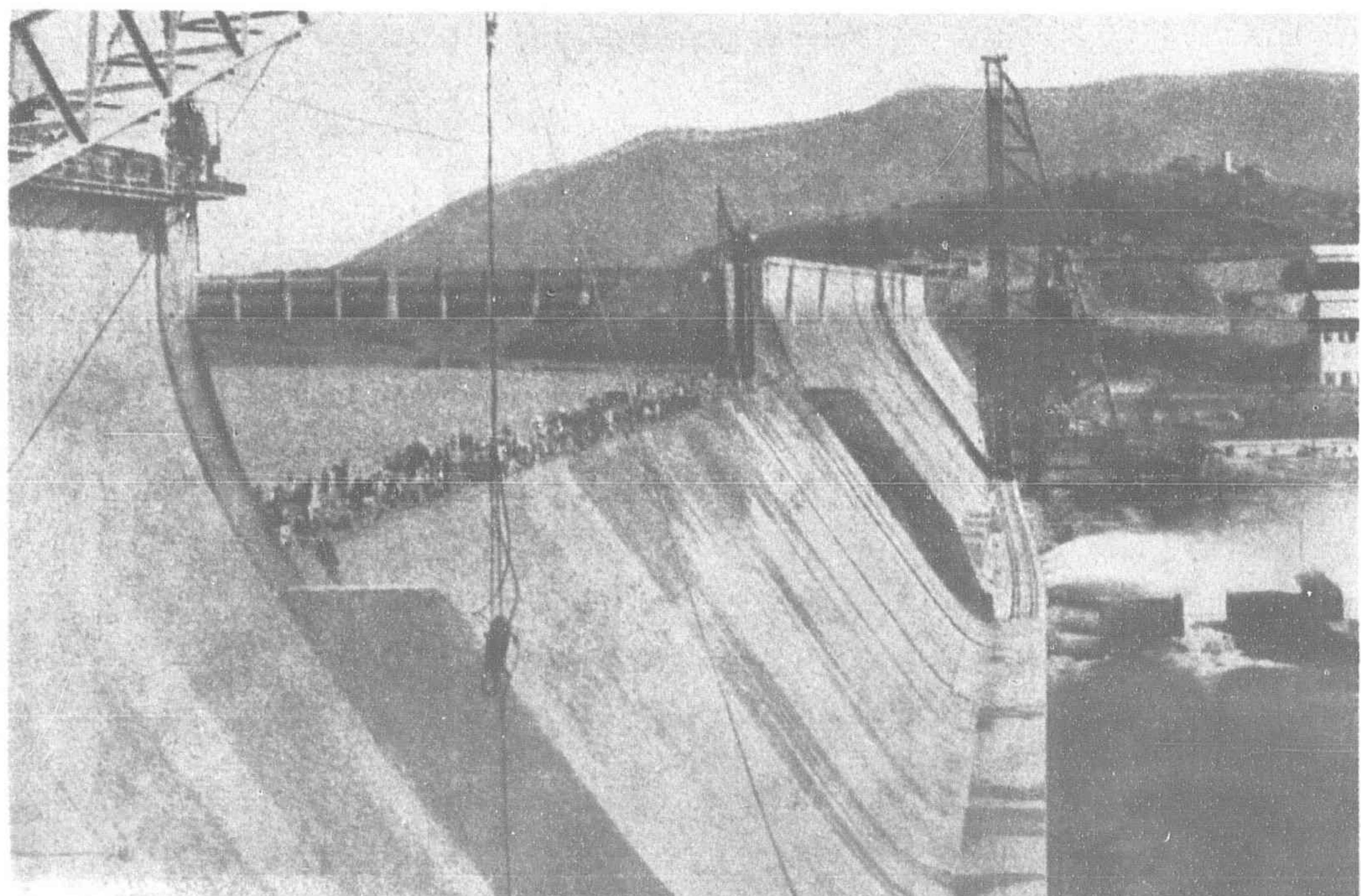
Erection of Surplus Works at Ellis Saddle



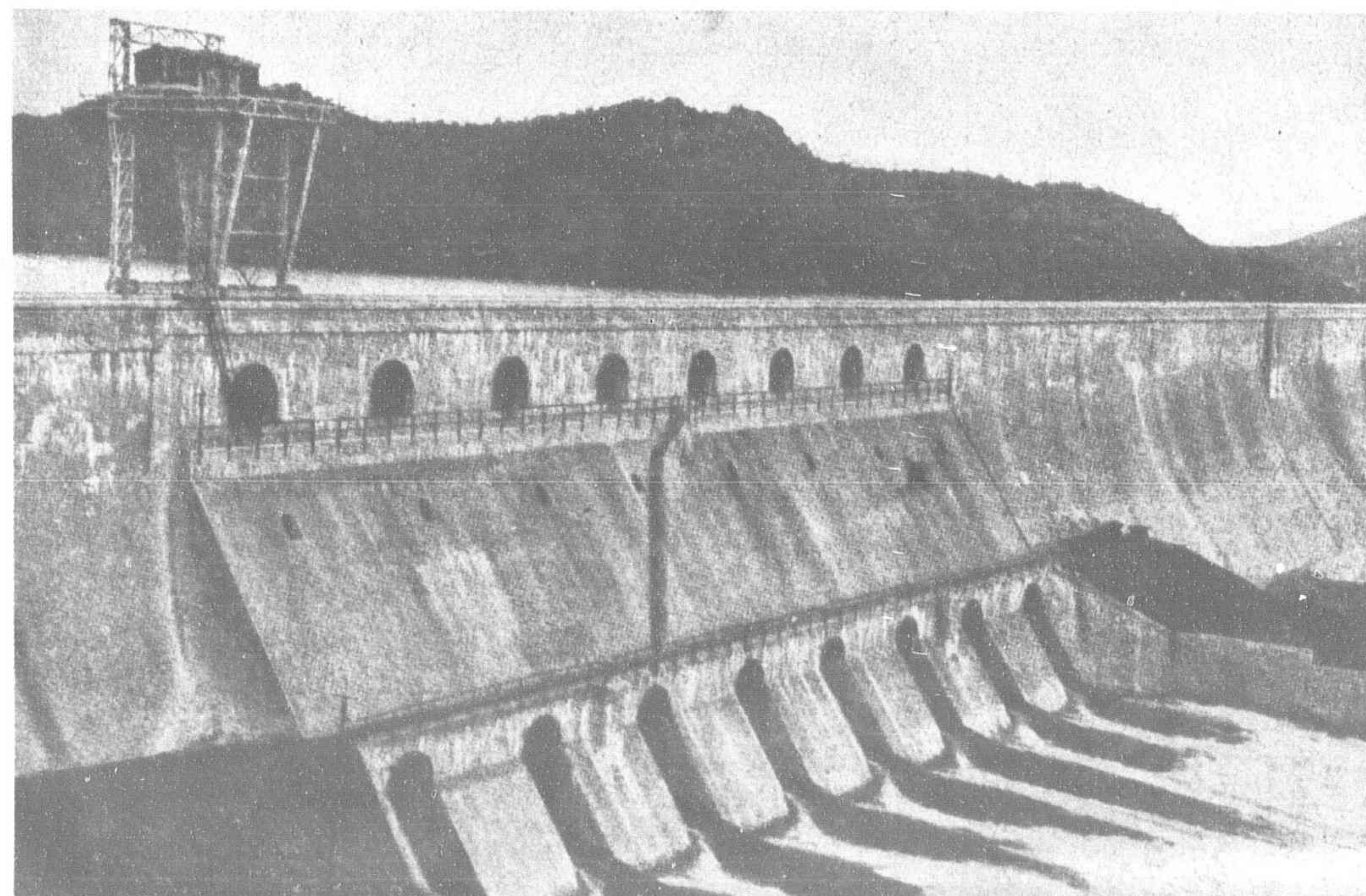
View of Dam from the South-East



View of Nearly Completed Dam



Overflow Section under Construction



High Level Sluices Discharging

of 8½ hours was about 900 tons each tower, and it was considered that it could not exceed 1,500 tons, even if worked for 12 hours in two shifts. Consequent upon this, it would appear that some delay was anticipated, and a difference of opinion arose regarding the advisability of having incurred such heavy expenditure on this plant.

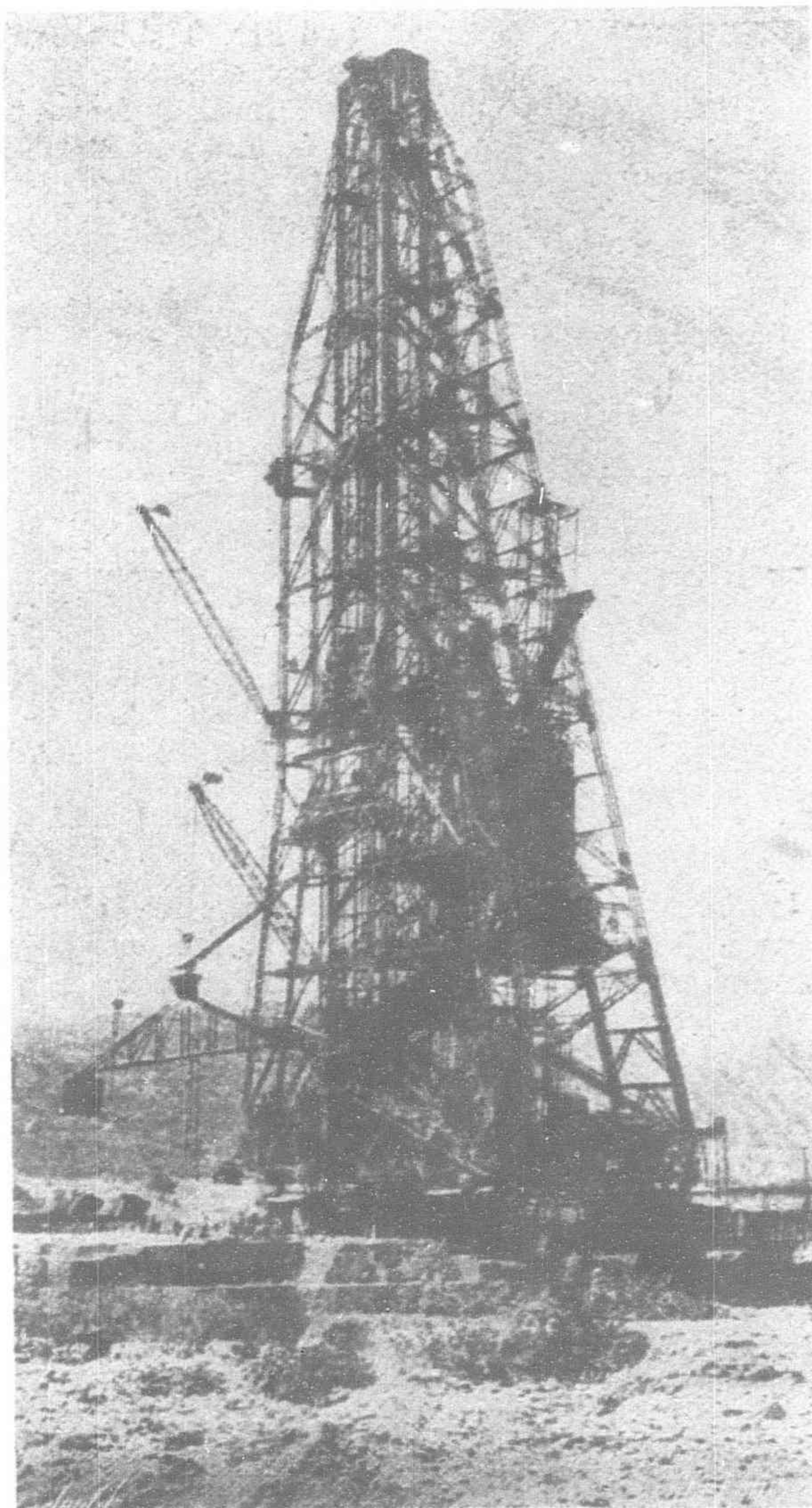
A change in the type of construction for part of the dam was decided upon, which involved the use of a large proportion of stone masonry laid in cement mortar, but in a note which was before the Public Accounts Committee in 1932, it was recorded that it is doubtful whether, if this change had been made in the initial stages, the engineer-in-chief would have decided to reduce the heavy plant and machinery. It was viewed by the authorities that the towers, far from being unnecessary, contributed to expedition, even under the changed design.

As has been stated, the original intention was to build the impervious face of the dam entirely in concrete, but it was found that the concrete, as delivered by the chutes, did not give the same percolation results as had been found in the original tests. An alteration was therefore made here also, and the entire face of the dam has been constructed in masonry laid in cement mortar. This mortar in the impervious face consisted of four-fifth part cement, one-fifth part surki, and four parts sand. Although the towers were originally intended for the mixing and distribution of concrete only, they were ultimately adapted and put to considerable use for the distribution and handling of heavy blocks of masonry and the distribution of mortar as well as continuing with their original function.

A drainage gallery, 7-ft. by 7½-ft., runs through the dam a little above ground level, for a total length of 4,240-ft., suitably sloped in either direction to three cross drainage outlets, one on either side of the river, and a third about 1,300-ft. from the right flank draining into the low level supply channel. Between the site of the high level supply sluices and the right flank, the drainage gallery is omitted, as the head of water will be comparatively small in this portion.

Temperature cracks are guarded against by forming definite joints between blocks of masonry at intervals of 126-ft. along the length of the dam. These joints run through from the upstream to the downstream face, and consist of alternate recesses and projections to retard the creep of water. They begin at drainage gallery floor level, and run vertically from that to the top of the dam. Briefly, they consist of a break in bond in the masonry. These joints are sealed with U-shaped flexible copper strips, embedded in the two blocks of masonry, and in front of these are diamond-shaped reinforced concrete posts, standing vertically on non-ferrous sliding plates and coated all over the vertical with marine glue. The water pressure holds this column against the joint, helped to some extent by the glutinous substance in which it is set. Should any water pass these columns, it has still to pass the copper strips, and should it get past the latter, it leaks harmlessly into the drainage shaft set on the direct line of the joint, and finds its way through the cross drainage galleries.

The whole of the work for this scheme, design and execution has been carried out by the engineers of the Public Works Department of the Madras Presidency. There have been a great many engineers of that service engaged thereon, but particular mention should be made of Mr. C. I. Mullings, C.S.I., who was responsible for the design of the final scheme as executed, and was engineer-in-chief for construction from the commencement until 1930. In that year he was succeeded by Mr. V. Hart, who has filled that post until the completion of the work.



Concreting Tower

We should also like to thank Stothert and Pitt, Ltd., and Glenfield and Kennedy, Ltd., for the assistance they have given us by supplying much information and data.

### Cauvery-Mettur Control Gear

By the courtesy of Glenfield and Kennedy, Ltd., of Kilmarnock, we are able to add to the description of the Mettur Dam some particulars of the control gear constructed by them.

Advantage will eventually be taken of the great volume of water available and the high head to install four turbines for the generation of electricity, although, to date, this plant has not been erected. For this purpose the dam has been pierced at its base with four culverts, 8-ft. 6-in. in diameter. Each culvert is lined with cast iron flanged pipes in 9-ft. lengths, and the entrances are bifurcated so that there are eight inlets of rectangular section. A drawing, reproduced as Fig. 1, indicates the general arrangement of these hydraulic culverts. The transition from each bifurcated rectangular entrance to the 8-ft. 6-in. diameter culvert is effected by means of specially shaped cast iron bellmouths, one of which is shown in Fig. 2.

These castings are placed at the entrance to the culverts immediately downstream of the point where the bifurcation unites, and the face of the castings is prepared to receive a free rolling emergency gate, which is lowered down a well extending from the top of the dam. The weight of each of these bellmouth castings, with grooves and lintel member, is 20 tons, giving a total weight of 80 tons for the four units. Each culvert is provided with two inlets protected by removable screens, one of which is shown in Fig. 4. These screens are lowered from the top of the dam, being guided by duplicate concrete guides and located at the culvert level in cast iron built-in grooves. The screens each measure 7-ft. wide by 25-ft. high, and are built up of mild steel round-edged bars measuring 3½-in. by ½-in., all held within built-up mild steel frames; the spaces between the bars are 2½-in. wide, and the free area through each screen is 150 square feet, giving a velocity of 3.33-ft. per second, when passing 1,000 cusecs. Rollers are fitted to each side of the frame to ensure that the screens can be lowered and raised easily. The weight of each screen is 5¼ tons, giving a total weight of the eight screens of 46 tons. Two spare screens are also provided for lowering down the duplicate grooves when it is necessary to clean the working screens.

### Needle Regulating Control Valves

At the downstream end of each culvert, and bolted to the cast iron lining, there is a regulating needle valve, 102-in./72-in. diameter. Its design provides for complete mechanical operation, the needle being controlled by a rack and pinion within the valve to which power is transmitted from a worm-gear operating headstock through a spur reduction gear. The advantage of this design is that the needle will remain firmly set in any position until again moved by the operating gear.

Since the pipe lines on which these valves are installed are intended, at a future date, when the dam is completed to supply water to turbines, air inlets have been provided at the nose of the valves to prevent cavitation during opening and closing. During the construction of the dam the flow of the river was taken through the hydro-electric culverts, and controlled by the needle valves. In order to avoid damage to the construction works at the toe of the dam from these powerful jets, each of which possessed potential energy of about 14,000 h.p., a jet disperser was fitted to

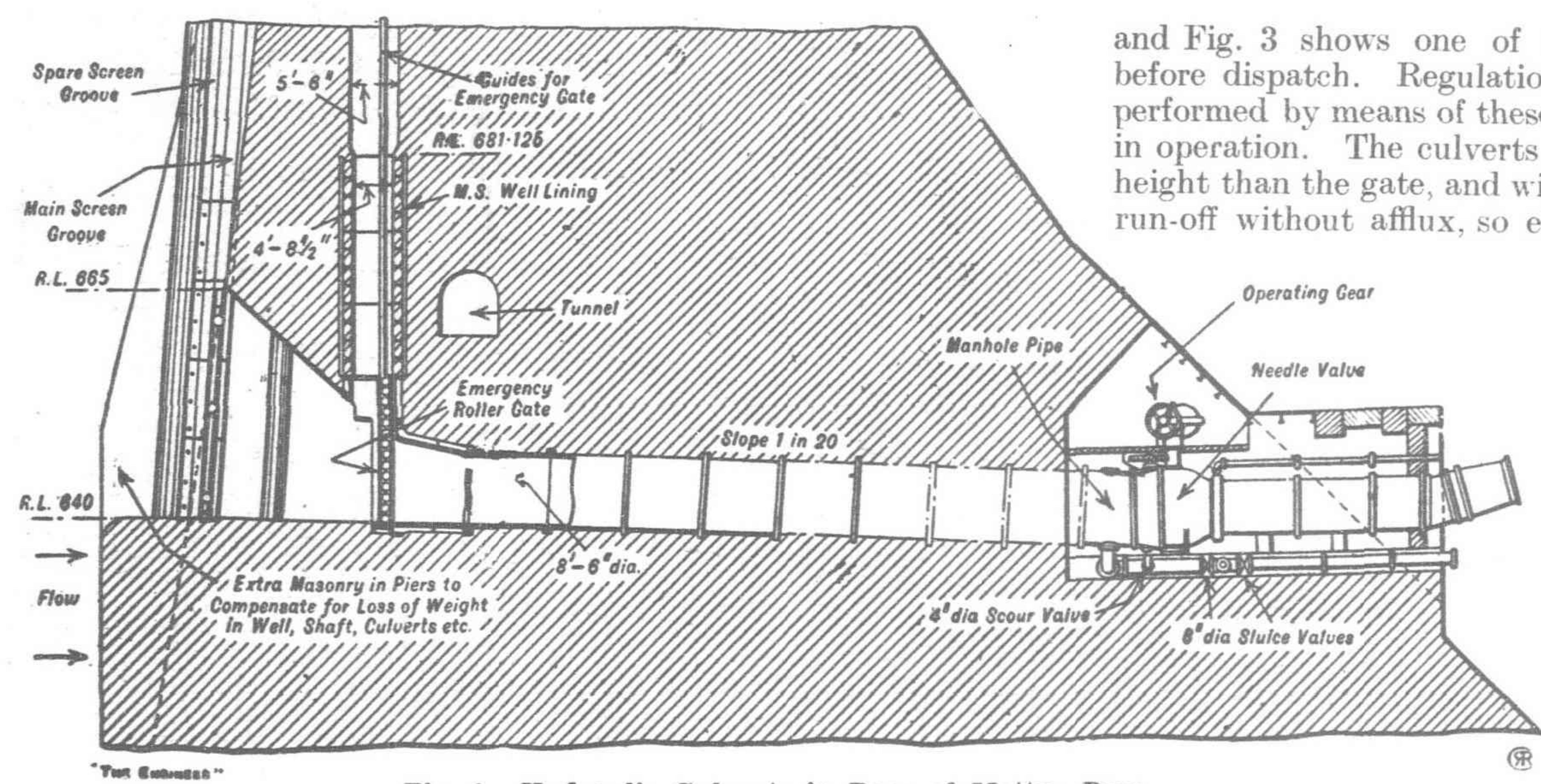


Fig. 1.—Hydraulic Culverts in Base of Mettur Dam

each outlet and connected to the needle valve by means of three intermediate lengths of straight cast iron pipe. The arrangement is clearly shown in Fig. 1, while a photograph, reproduced herewith shows three of these units discharging under a head of 80-ft. The discharge is free from any danger of erosion, and falls harmlessly on to a shallow water cushion, and the engineer reports that, although the water cushion on to which these jets discharge is extremely shallow, there is practically no disturbance.

Low-Level Culverts

At level 670.0 there are installed five sets of culverts with free roller sluice gates and entrance bellmouth linings of cast iron. A section of the dam through one of these culverts is also reproduced

and Fig. 3 shows one of the sluice gates and linings erected before dispatch. Regulation of the flow through the culverts is performed by means of these sluice gates, which will be constantly in operation. The culverts are specially designed with a greater height than the gate, and with slope to the outlet to ensure a clear run-off without afflux, so eliminating all possibility of vibration.

On the upstream side of the bellmouth, which is machined, a free rolling emergency gate can be lowered to close off the culvert entrance for inspection or repair of the tunnel lining and sluice gate. In Fig. 3 it will be seen that one of the sections of the free roller grooves has been removed to reveal the free roller train within, and the manner in which the rollers are completely protected from the high-velocity stream to eliminate vibration is clearly shown. The gates are sealed on the upstream side by machined adjustable members meeting con-

tact faces on the built-in frame. By providing this arrangement on the upstream side, adjustment can be effected with the gate under water pressure, and the gate being of the dry-well type is not subjected to heavy unbalanced hydraulic loads when in partially open positions.

The following table of the weights of the various parts of these low-level culvert equipments is given as a matter of interest :—

	Weight each Tons	Total weight Tons
Five mild steel free roller sluice gates, 7-ft. span by 14-ft. high.	8 $\frac{3}{4}$	43 $\frac{3}{4}$
Five cast iron frames for gates ..	20 $\frac{1}{2}$	102 $\frac{1}{2}$
Five cast iron linings for bellmouth	25	125

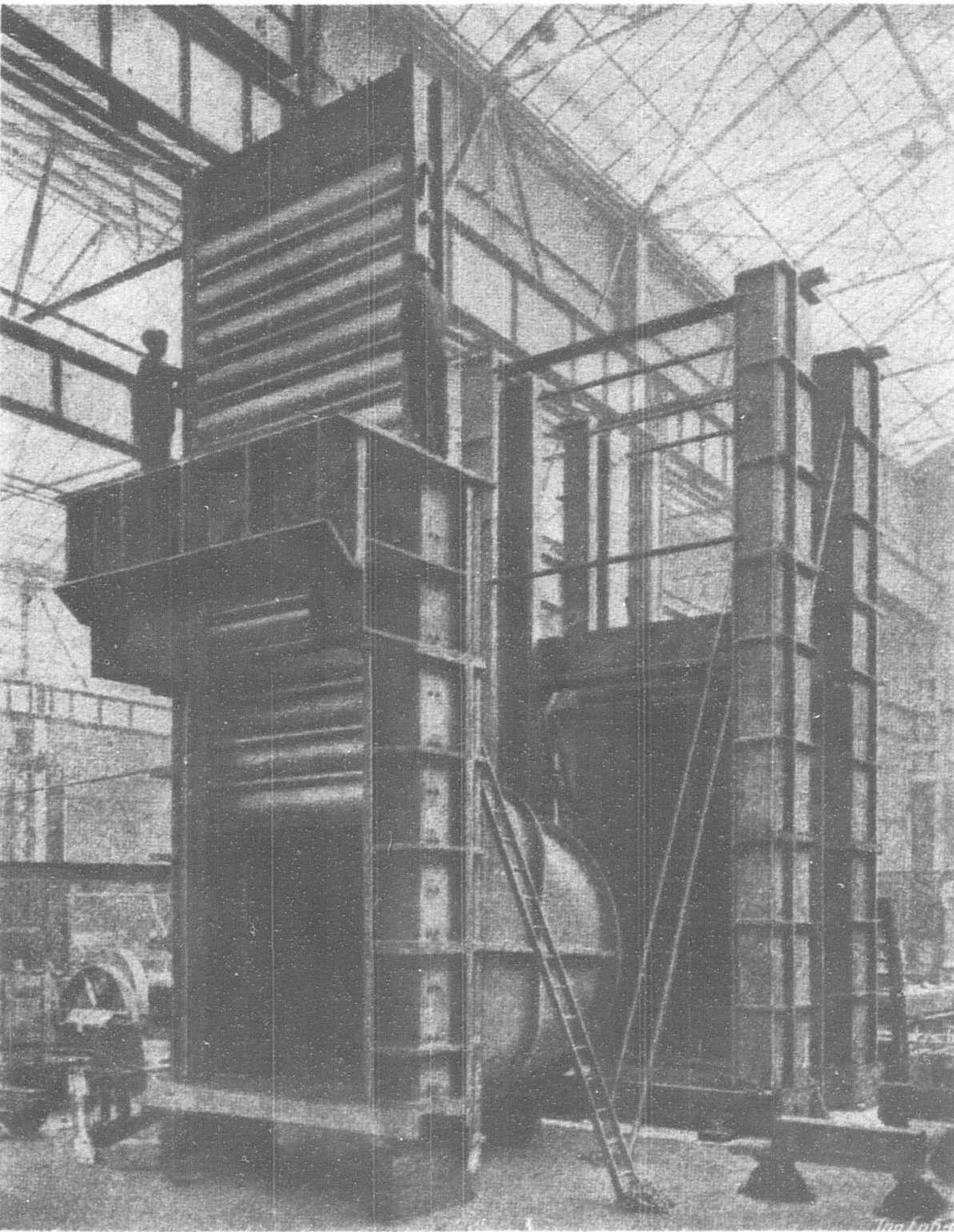


Fig. 2.—Bellmouth and Roller Gate for Hydraulic Culverts

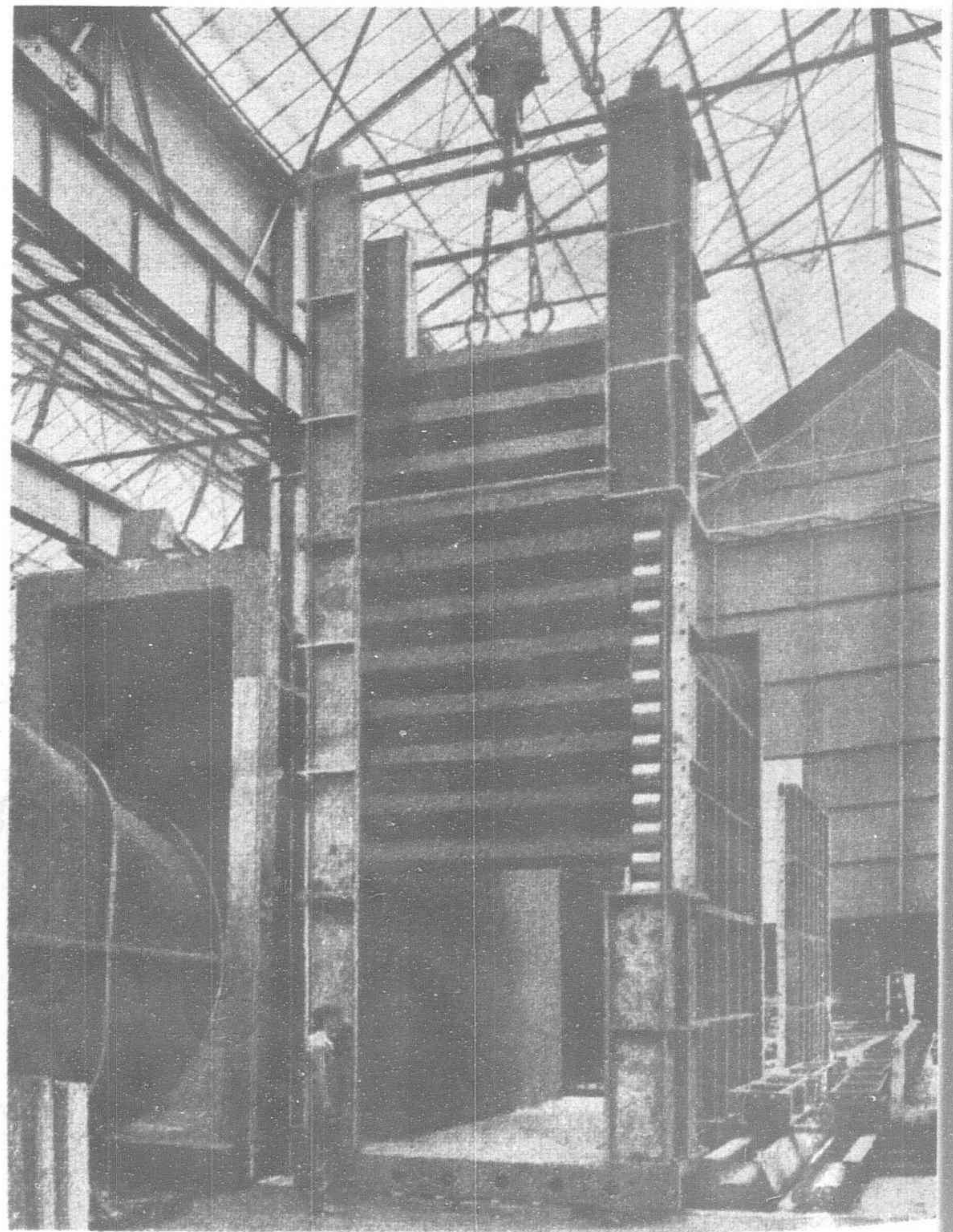


Fig. 3.—Roller Gate for Low Level Sluices

These low-level sluices are operated from a platform near the top of the dam by electrically controlled worm-gear head-stocks. The design of the controls is similar to that for operating the high-level sluices, described later. The operating power is transmitted from the electric motor through reduction gearing consisting successively of a roller chain drive, worm and worm wheel, and spur gears, and thence to shafts on which are keyed the sprocket wheels engaging with link chains attached at their ends, to the gate and balance weight respectively.

The whole of the gearing is totally enclosed and stormproof ventilating openings are provided on the headstock covers for cooling the motors. The sprocket wheels are similarly totally enclosed, and the limit switches for cutting off the current at each end of the gate travel are housed within covers situated on top of the sprocket casings.

In order to facilitate lubrication of all working parts from outside the casings, lubrication pipes and lubricators or oil cups are provided for every bearing. In this connection particular attention is paid to the lubrication of the worm reduction gear, which runs in an oil bath, the oil level being observed in a gauge and maintained through a filler accessible from outside the head-stock. One of the most important features of the operating equipment is the provision of an automatic centrifugal clutch coupling installed between the motor and the chain drive, which only comes into engagement when the motor has attained full speed, and disengages automatically in the event of an overload, thereby protecting the motor and the whole of the operating gear from possible damage.

The levelling and adjustment of the headstock in its position on the supporting girders is carried out by means of a number of screwed bushes provided on the lower flange, and through which the holding-down bolts pass. By this means the whole gearing can be set up in true alignment with the greatest precision and facility.

Similar gear is provided for the operation of the surplus gates on Ellis Saddle. Here, however, since the connecting shafts are of considerable length, a micrometer coupling adjustment is arranged

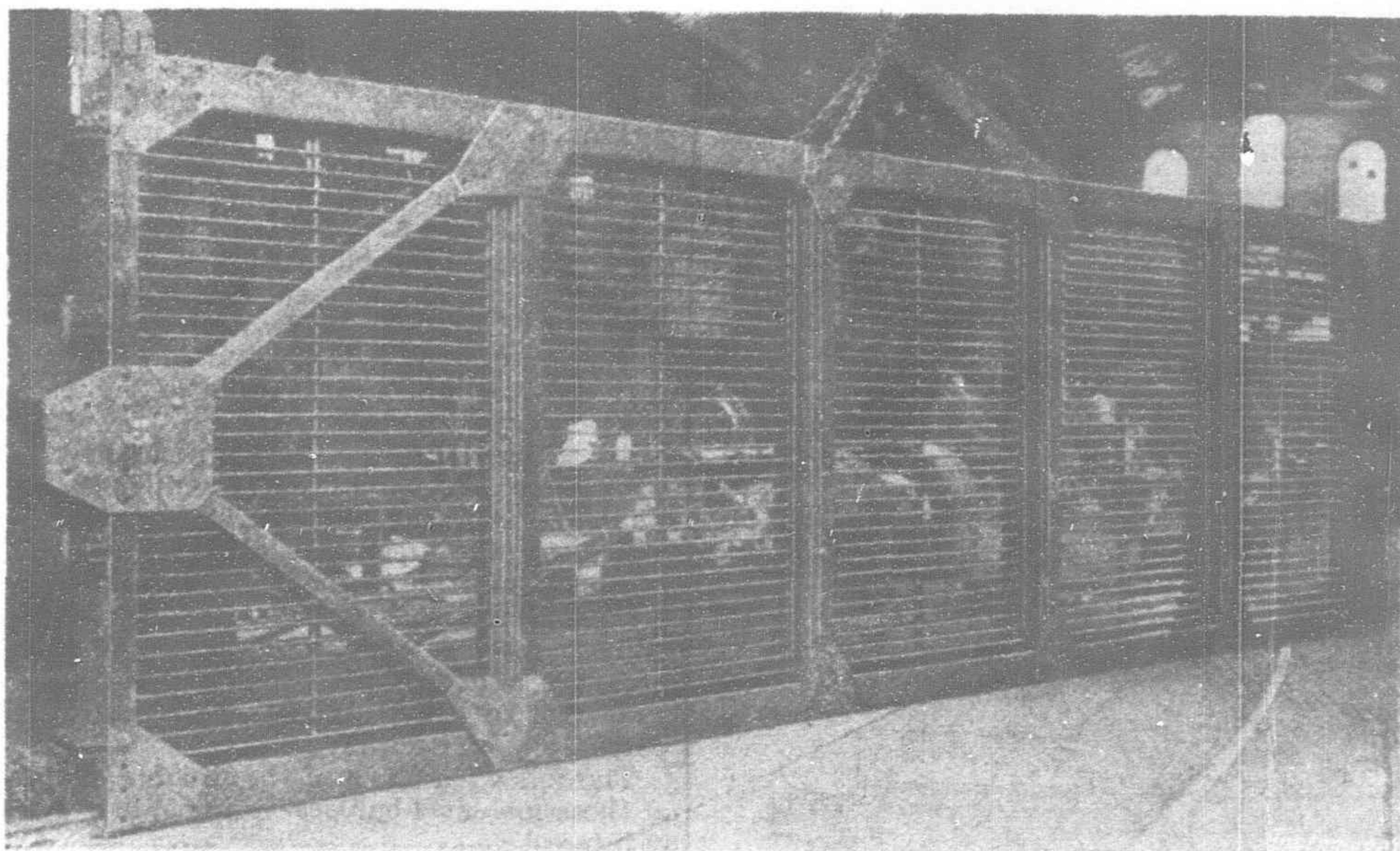


Fig. 4.—Removable Screen for Hydraulic Culverts

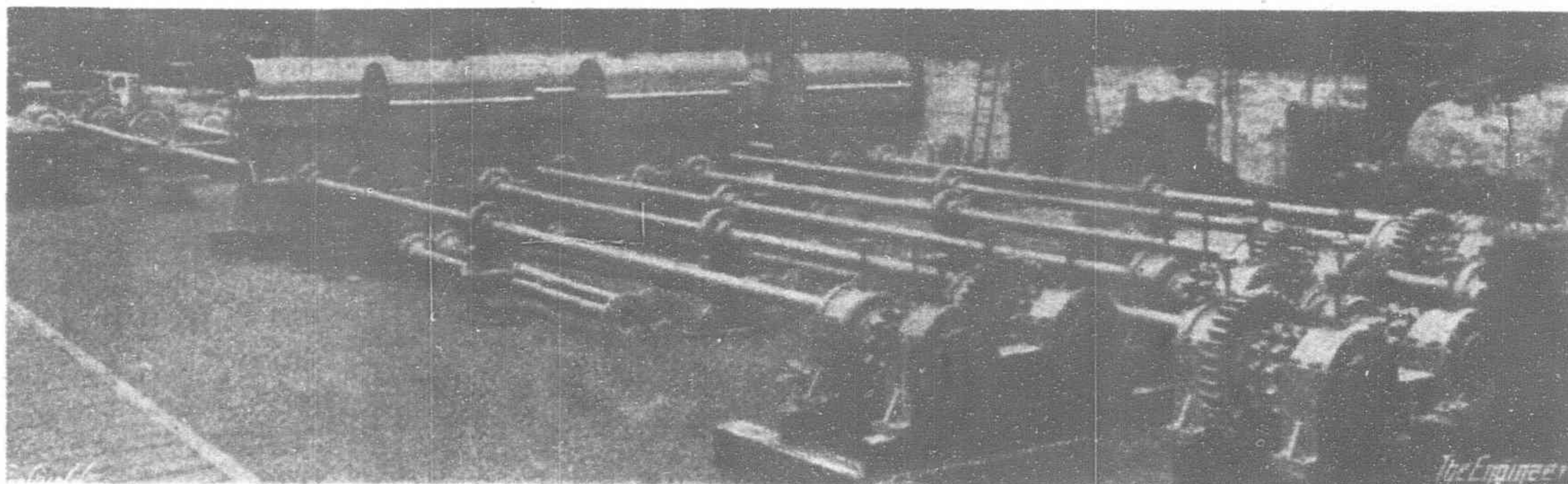


Fig. 5.—Operating Gear for Sluice Gates at Ellis Saddle

to take up any wear that may take place in the chains. This arrangement is necessary in case one of the chains wears or stretches to a greater degree than the other, and consists in providing one of the half couplings with one more bolt hole than the other on a pitch circle of the same diameter. Connection is made by one bolt only, and by this means the two halves of the coupling can be

bolted together in a great number of different positions, each varying very slightly from the other. Also, on these surplus gates, owing to the very great loads to be dealt with, and to reduce the operating power to a minimum, the sprocket wheel shafts are mounted on self-

aligning roller bearings.

On all the sluice gate headstocks there is an indicator showing exactly the opening of the gate. It takes the form of a circular dial cast on the outside of the headstock casing, and having a centrally placed pointer driven from the gearing within. The scale is graduated in feet, and the operator can thus see, with the greatest ease, the exact opening of the gate at any time.

It will be noticed from the photograph reproduced in Fig. 5 that a crank handle for emergency hand operation has been provided. An emergency safety cover must be lifted to engage the handle. The lifting of the cover causes a switch in the hinge to break the operating motor circuit, and the motor cannot be started. This condition exists until the crank handle is removed and the cover closed.

### High-Level Culverts

At level 720.0 there are installed eight sets of culverts controlled by free roller sluice gates, each measuring 10-ft. 6-in. wide by 16-ft. deep. The design is similar to that described for the low-level culverts, and the operating gear is identical. The weights of the various parts are as follows:—

	Weight each Tons.	Total weight Tons.
Eight 10-ft. 6-in. by 16-ft. free roller gates . . . . .	12	96
Eight cast iron sluice frames	25	200

Fig. 6.—Sluice Gate and Balance Box

Free Rolling Emergency Sluice Gates

It has been briefly mentioned above under the heading of "Hydro-electric Culverts" that free rolling emergency sluice gates are being provided. Two sizes of these gates have been supplied, one to suit the hydro-electric culverts and low-level culverts, and the other suitable for the high-level culverts. The gate consists entirely of rollers spanning the clear opening, and is accommodated at the culvert level on machined cast iron frames. The main rollers of the gate rotate on axles held between side members, and the spaces between are staunched by means of smaller rollers loosely retained in position, and kept in contact with each pair of rollers by the water pressure on the face. As the gate is lowered in front of the culvert the rollers rotate the main rollers in one direction, driving the staunching rollers in the opposite direction. The resistance to motion is very small, being practically confined to rolling friction, and the gate descends under its own weight even when the culvert is discharging freely to atmosphere. The sides of the gate are staunched by means of spring brass strips bearing on the side members and built-in frame respectively. Leakage past the gate is small. Tests conducted on a similar gate, 8-ft. span by 15-ft. high operating under 82-ft. head, showed a leakage of only 1.36 cusecs. This amount is negligible when compared with a culvert of that size, and for all practical purposes may be considered tight.

For operating these free rolling emergency gates, and also for lifting and replacing the screens in front of the hydro-electric culverts, two Goliath cranes are installed, one being of 50 tons capacity, and the other having two lifting blocks, one of 50 tons and the other of 10 tons, the latter being for the screens.

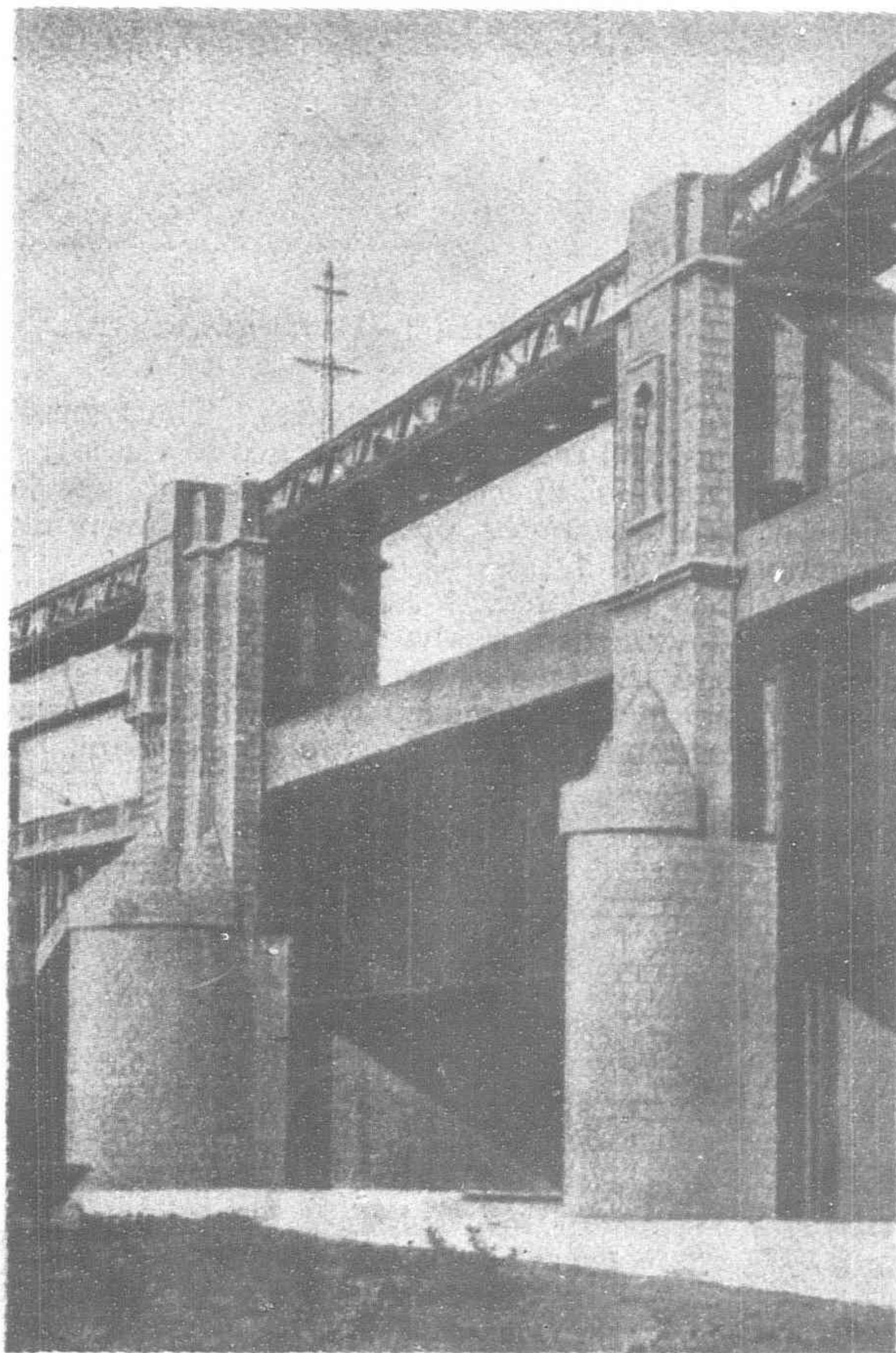


Fig. 7 Surplus Gates at Ellis Saddle

Surplus Gates

At one side of the dam, known as the Ellis Saddle, arranged on a curved crest, there are sixteen flood discharge gates, each measuring 60-ft. span by 20-ft. deep, all of the free roller type, electrically operated and counterbalanced. A gate and balance box under construction are shown in Fig. 6. These gates are built up from a number of horizontal lattice girders spaced vertically at such distance as will give an equal loading from the water pressure to each girder. The free rollers are housed within protecting cast iron grooves. The gate end posts are fitted with self-aligning articulated paths upon which the free rollers travel. These paths automatically compensate for the deflection of the gate under varying water load, and ensure the rollers having full contact across their faces under all conditions. By attaching these articulated paths to the gate instead of installing them in the built-in groove, they are raised with the gate each time it is opened, and the swivelling pins and bearings are thus available for inspection without the necessity of coffer-draining the culvert and dewatering the sluice bay. The operation of the gates is by means of worm-gearred headstocks gearing with sprocket wheels, which, in turn, engage with bush link chains connecting the gate and counterbalance. All the headstocks are electrically controlled, and all parts of the gearing are covered for protection from the sun and rain.

The operating gear is carried on steel crossbridges, built up of rolled steel sections. The completed surplus gates are shown in Fig. 7, while a view of the Ellis Saddle through the gap in the dam closed last season is also shown in an accompanying illustration.

Japanese Engineering

IN the manufacture of machinery, as in other directions, Japanese industry is rapidly developing. Foreign machinery, which for many years predominated, has already been back-seated in the domestic market, and Japanese-made machinery, in competition with foreign products, is finding an increasing market abroad in such countries as China, India, Russia, and even far-away Brazil. The remarkable strides made in recent years by the machine-making industry of Japan are revealed in a report just to hand. Machinery imported in 1929 was valued at Y.121,094,000, contrasted to Y.72,657,000 in 1933. Internal-combustion engines entering the country last year were worth Y.16,147,000, against Y.18,113,000 in 1929. Small-type engines were completely displaced by home products. The total value of sewing machines imported was Y.9,220,000 in 1929, but last year the figure slumped sharply to Y.2,060,000. Machinery for spinning and weaving, imported to the value of Y.14,486,000 in 1929, sank to the low level of Y.3,520,000 last year. The only exceptions were metal and wood-working machines. These rose from Y.5,624,000 in 1929 to Y.16,247,000 in 1933, an increase accountable to extraordinary activity in the munitions industry. Air compressors imported last year were worth only Y.669,000, against Y.2,539,000 in 1929. Japanese-made machinery exported during 1933 was worth Y.25,857,000, against Y.10,943 in 1932 and Y.13,641,000 in 1931. A list of principal exports during the past three years is:

	1933	1932	1931
	(In Y.1,000)		
Spinning and weaving machines ..	4,878	3,650	5,156
Electric machines .. ..	2,724	1,414	2,686
Printing machines .. ..	900	371	248

Pumps .. ..	909	344	351
Boilers .. ..	577	343	408
Metal and wooden machines ..	566	216	219
Other machines .. ..	15,301	4,601	4,569
Total .. ..	25,857	10,943	13,641

Spinning, weaving and electric machines were the most important items. Countries of destination within the past three years follow:

	1933	1932	1931
	(In Y.1,000)		
For			
Manchoukuo .. ..	1,938	394	150
Kwantung Leased Territory ..	14,197	3,953	4,280
China .. ..	4,951	3,848	6,731
Hongkong .. ..	119	107	177
British India .. ..	2,104	900	470
Dutch East Indies .. ..	312	123	80
Soviet Union .. ..	1,328	1,179	1,364
Brazil .. ..	104	73	34
Australia .. ..	31	41	3

Japanese spinning and weaving machines have unique features. The famous Toyoda automatic weaving machine cuts down labor. A British firm purchased the patent for Y.1,000,000, but when the machines were installed in England, a vigorous protest was raised by British mill hands. Last year 25 Toyoda machines, having 400 spindles, were shipped from Japan for use in spinning mills at Ahmedabad, India.—*Eastern Engineering and Commerce*.

# The Design and Construction of the Hu Tuo Ho Irrigation System\*

By HSU SHIH-TA, M.C.E.; M.A.M.SOC.C.E.; Executive Member and Chief Engineer, North China River Commission; Director, Hu Tuo Ho Irrigation Works; Member of the Association of Chinese and American Engineers

THE Hu Tuo Ho Irrigation System, located north-west of Shih Chia Chuang along the Ping-Han Railroad, is now under construction. The whole system was planned to irrigate farm land in the Lin-shou, Hu-lu, Ch'en-ting, Hsin-tang, Hsing-lo, and Ping-shan Districts, covering an area of about 355,000 mou, by diverting part of the water from the Hu Tuo Ho, a river obtaining its source from Wu-tai Shan in Shansi, and finally joining the Fu-yang Ho commonly known as the Tze-ya Ho. Owing to lack of funds, it was planned to divide the entire work into three stages, the first stage to irrigate the Lin-shou and Ch'en-ting Districts, the area of which is about 130,000 mou. The benefited lands will have to pay back the investment on the proposed system, and the money thus derived will be available a few years later for the use of constructing extension works.

There is nothing new in the design of the engineering structures and the plans of the canal system; however, the attempt made in the design and construction to come within the limited funds available and to combat difficulties arising from mere ignorance and the traditions of the people of the region may be worth the attention of fellow engineers.

The greatest difficulty met in the design was to determine the possible maximum flood height. Owing to the lack of both data and funds, the balancing between safety and economy required a full investigation of the hydrological conditions of the valley and several revisions were made before the final conclusion was reached. The opposition of the people living above the diversion work led the engineers to a careful search of all the available data and a proposition to protect the lands by dikes settled the question.

The second question to be answered was the selection (a), between a pumping system and gravity system with auxiliary pumping, and (b), between a unit diversion dam with regulator on both banks and a separate intake for each. The question is both economical and technical, especially as the long diversion dam proposed is rather a pioneering work in this province and the people concerned were more or less in a vagabond state of mind. The villagers living above the dam feared that the raising of the water surface would become a perpetual threatening to their lives and property, although the design of the dam had taken into due consideration the interests of the people upstream.

The third problem involved was to minimize the first cost of construction in order to come within the available funds but at the same time not to injure the safety and unity of the whole plan. Such works as may be changed or extended without much difficulty and undue expense were designed only to meet the requirements of the first stage, in certain cases even for a portion of the first stage plan in order to begin the irrigation at the earliest date, but works which would be permanent were given their fullest consideration as to their capacity.

The whole system consists of a diversion dam with sluices on both sides, a regulator

and a leading canal, an auxiliary sluice for the canal, the main canal and laterals, the pumping plants, etc., (not including the works for the irrigation system on the south bank).

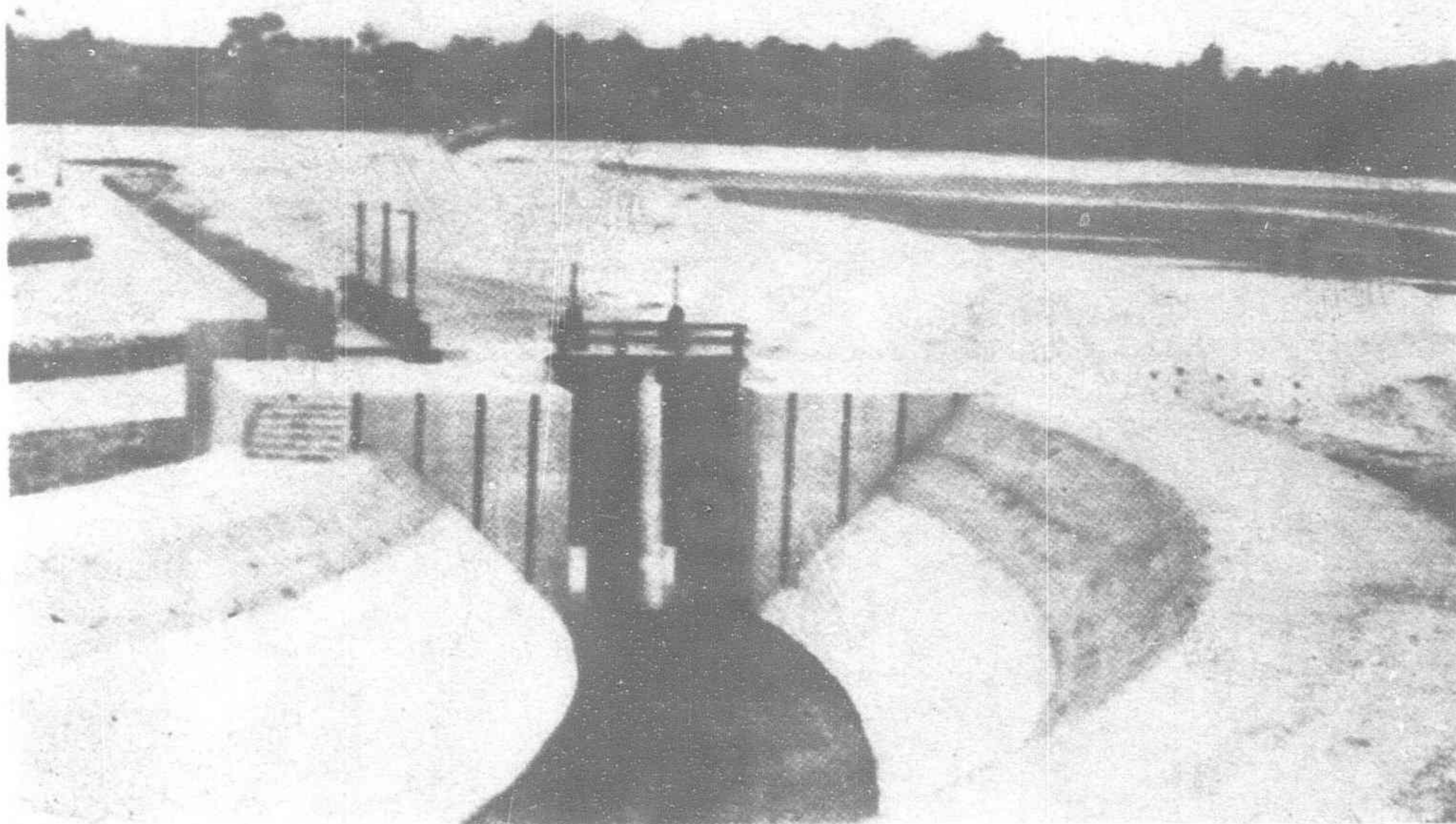
## The Hu Tuo Ho and its Hydrological Investigations

The Hu Tuo Ho drains the waters from Wu-tai Shan in Shansi, and enters Hopei Province after running a distance of 300 kilometers. Its watershed abuts on the Sang Kan Ho on the north, the Feng Ho on the west, the Chang Ho on the south, and the Tang Ho and the Sha Ho on the east, being enclosed practically on the four sides by high mountains with peaks from 1,600 to 3,100 meters above sea level, except a low gap at the south-west, the divide between the Feng Ho and the Hu Tuo Ho, which is 1,200 meters in elevation. Before entering the Hopei border, the river carves its way through mountainous regions forming a tortuous and deep gorge, with a slope of about 1:200 to 1:300. The valley gradually opens after it passes the border, and the river travels through the high terraced loess plain for about 60 kilometers until it reaches the great flood plain of Hopei. The longest branch of the Hu Tuo Ho is the Yeh Ho, which flows northeasterly from the Shou Yang District in Shansi and joins the Hu Tuo Ho at the north of the Ping-shan District in Hopei. Along the Yeh Ho, several canals were constructed and operated by the farmers of the Chin-hsin and Ping-shan Districts. The total drainage area of the Hu Tuo Ho is 23,800 square kilometers at the Ping-Han Railway bridge.

The river gaging of the Hu Tuo Ho was started by the former Chihli River Commission in 1919 at the Ping-Han Railroad bridge. The work has been continued by the North China River Commission up to date. Another gaging station was installed at Huang Pi Chuang, about 25 kilometers upstream from the railroad bridge but the gaging was discontinued for a long period until 1933. Other flood data were obtained merely from flood marks and flood heights from the memory of the villagers. Low water measurements were not made by the former Chihli River Commission. A gaging station was established at Niu-cheng, about two kilometers upstream from Huang Pi in 1931 and the low water gaging at Huang Pi began last year. Rainfall records were also obtainable from various stations located in or near the watershed.

The hydrological studies relating to the problems are twofold: (a) the maximum flood heights which should be considered for protection of the structures and the villages above and (b) the minimum low flow which can be diverted for irrigation.

The annual maximum flood discharges are tabulated in Table I. This table shows the year, month, location, and depth of maximum rainfall at the center of storm



The North Regulator and Sluice, Hu Tuo Ho Irrigation System

\*This article was read July 10, 1934, at the Annual Meeting in Tientsin of the Association of Chinese and American Engineers.

# 滹沱河灌溉計畫總圖

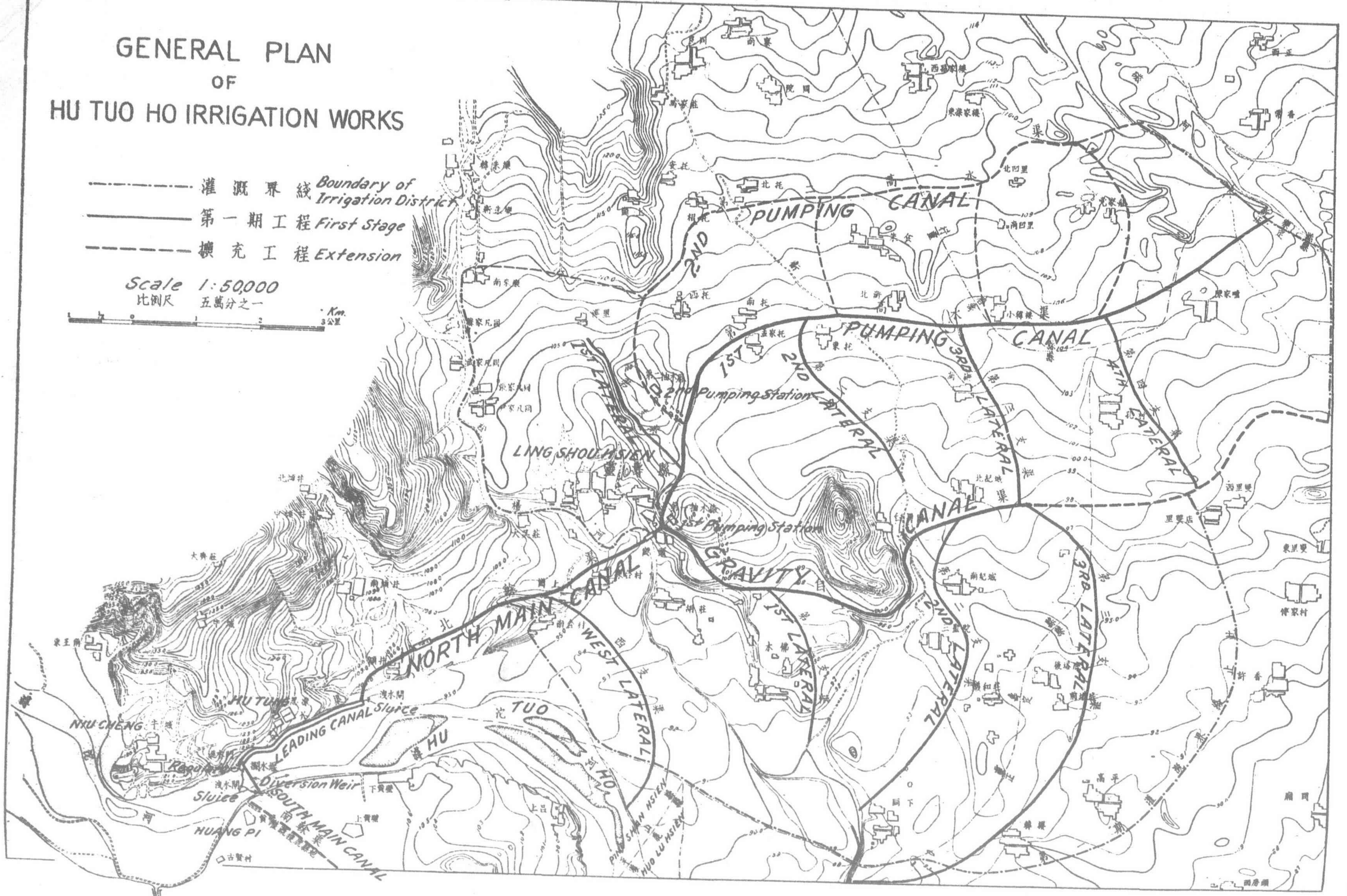
## GENERAL PLAN OF HU TUO HO IRRIGATION WORKS

- 灌溉界綫 *Boundary of Irrigation District*
- 第一期工程 *First Stage*
- 擴充工程 *Extension*

Scale 1:50,000

比例尺 五萬分之一

Km  
3公里



However, the Hu Tuo Ho has experienced several extraordinarily high floods, the nearest records being one in 1917 and another in 1852. The flood discharge in 1917 has been a puzzle since the former Chihli River Commission recorded it as 10,000 cubic meters per second and suffixed it with a question mark "?". The figure was estimated from flood height near the Ping-Han Railroad bridge, but how the Commission got the elevation and how they estimated the discharge is not known. The figure is evidently misleading because in 1917 many rivers experienced high flood which was not much higher than that which occurred in 1924 when the largest estimated value was 5,000 cubic meters per second (Yung Ting Ho and Chang Ho). The mistake probably comes from one or both of two sources: the misreport of flood height by the villagers and the under-estimate of the obstruction of the railroad bridge, one bridge span being carried away by the flood and rebuilt and enlarged later.

TABLE I.  
HYDROLOGICAL RECORDS OF ANNUAL FLOODS OF THE HU TUO HO

Year	Month	Center of Storm	Maximum Rainfall mm.	Date	Maximum Rainfall in or near Hu Tuo Ho Watershed mm.	Station	Maximum Flood Dis- charge	Date of Occurrence	Note
1919	July	Tung Hsien	285	27-28	84	Shih Chia Chuang	2,000 ?		
1920	July						118	6th	No heavy storm
1921	Aug.						184	26th	No heavy storm
1922	July	Tse-chin Kwan	635	21-24	140	Hsin Hsien	1,163	24th	
1923	Aug.	Chang-ti-Fu	464	9-11	52	Shih Chia Chuang	910	9th	
1924	July	Tse-chin Kwan	327	11-13	144	Ch'en-ting	1,750	12th	
		Tsan Huang	267						
	July	Lin-min Kwan	595	15-17	107	Ping-shan	740	17th	
1925	July	San-chia-tien	368	23-25	88	Hu-lu	900	27th	
		Chang-ti Fu	189						
1926	July	Hsiao-chang	297	13-15	139	Ping-shan	465	15th	
1927	July						178	15th	No heavy storm
1928	July	Ti-sho-ya	172	12-14	117	Shou Yang	1,100	13th	
		Shou Yang	117						
1929	July	Peiping	273	16-18	130	Tai Hsien	570	18th	July 15-17 at Tai Hsien
	Aug.	Peiping	373	1- 5	65	Shih Chia Chuang	308	5th	
1930	Aug.	Lu-lung	364	2- 4	41	Tai Hsien			
		Yun-nien	198						
1931	July	San-chia-tien	289	6- 8	102	Shih Chia Chuang			

Anyhow, this flood record affects very much the design and cost of structures. Still more important was the opposition of the villagers against the construction of a diversion dam for fear of being damaged by the backwater. Accordingly extensive research work was done on the 1917 flood heights, including those pointed out by the opposing party. Those which came from unbiased sources led to the conclusion that the 1917 flood was not greater than 4,000 cubic meters per second while those pointed out by the opposing party had been estimated as great as 42,900 cubic meters per second ! The lower figure is more reliable because it was deduced from different sources of information and because it is more in accord with the general flood conditions in 1917 and flood records of the Hu Tuo Ho itself. This daring adoption of 4,000 cubic meters per second as a maximum flood has still other reasons : firstly, these floods would not occur more than once in every 60 years (from 1852 to 1917 being 65 years while one before 1852 was recorded in 1792), and it would be more economical to rebuild the structures damaged by higher floods than to allow a greater margin for safety in the construction of these structures ; and secondly, in order to pacify the villagers living above the dam, a proposition to build dikes was made but the gentry and leaders of these villages, strongly refused to accept the gift for the reasons that the Hu Tuo Ho flood water in 1917 had not reached the land (a flood less than 4,000 cubic meters per second), and that the building of dikes would obstruct the drainage of hilly lands and do greater damage than before. In fact, the opposition was stirred up by a few leaders for certain other purposes, but the final conclusion of maximum flood discharge from this investigation resulted in the saving of quite a big sum in the construction.

The low water gaging has extended over only a short period of time, from December 1931 to the present. The lowest level

occurred in April and May of the year when the irrigation canal along the Yeh Ho was in operation.

Table II shows the gaging data at Niu-cheng.

The lowest records of gage reading did not last long in each year, occurring for about three days both in 1932 and 1933. On April 26, 1933, when by chance the gage reading was 100.95, the writer made two independent measurements by float and estimated roughly the discharges to be 15 to 20 cubic meters per second. The lowest reading in that year was 100.92, only three centimeters lower than the above figure. This year (1934), the low water gaging records were 100.97 in April and 100.95 in May. The discharge measurement at Huang Pi when the gage read 100.97 at Niu-cheng was 11.4 cubic meters per second. In this year this lowest gaging of between 100.95 and 100.98 occurred only five days, not consecutively. From these three years' low water records, it seems that the river bed is gradually built up (in fact the two surveys made between 1923 and 1933 on the river show that tendency) and the minimum flow of Hu Tuo Ho at Niu-cheng will be around 10 cubic meters per second while for the greater part of the irrigating season it will be more than 15 cubic meters per second. The building of a dam and the operation of the sluices and regulators will probably equalize the fluctuation of flow (only for three to five days below 10 cubic meter per second) and make this irrigation system run at its full capacity. If further records disclose that there is a still lower flow than the one observed, it can be remedied easily by building shutters above the dam and providing a certain storage to meet the requirement. Further investigation on the possibility of reservoir construction on the upper Hu Tuo Ho or Yeh Ho will be made for the full development of the watershed.

TABLE II.  
GAGING DATA AT NIU-CHENG

Year		January	February	March	April	May	June	July	August	September	October	November	December
1931	Max. Min. Aver.												101.13 100.99 101.05
1932	Max. Min. Aver.	101.34 100.99 101.07	101.11 101.02 101.06	101.23 101.03 101.13	101.13 101.96 101.04	101.09 100.86 101.02	101.54 100.93 101.07	102.48 100.87 101.28	102.62 101.27 101.56	101.88 101.36 101.66	101.37 101.14 101.25	101.21 101.14 101.18	101.20 101.12 101.17
1933	Max. Min. Aver.	101.21 101.12 101.18	101.23 101.12 101.19	101.27 101.10 101.19	101.21 100.95 101.16	101.16 100.92 101.00	101.65 101.03 101.30	101.73 101.22 101.41	101.74 101.24 101.42	101.62 101.20 101.29	101.33 101.21 101.26	101.26 101.18 101.21	101.25 101.17 101.20
1934	Max. Min. Aver.	101.22 101.07 101.13	101.37 101.09 101.21	101.46 101.19 101.30	101.21 101.97 101.13	101.11 100.95 101.00							

## The Hu Tuo Ho Irrigation System

The use of water from the Hu Tuo Ho to irrigate the high lands of Lin-shou was proposed first by the District Government in 1931. The project consisted of a pumping plant at Niu-cheng, where the river channel is near its north bank, and a canal system to distribute the water. The District Government petitioned the North China River Commission both for technical investigation and for financial aid for the project. An extensive topographic survey was made in the winter of that year. The result of the survey disclosed the non-economy of the proposition. The banks at Niu-cheng are about 20 meters higher than the river, and hard rock can be found at a moderate depth. If pumping be limited to a height of 10 meters, a deep cut through the rocks up to a depth of 8 meters extending for a length of a few kilometers might cost a great deal, without considering the cost of the pumping plant and the operation expense for bringing water up to a height of 10 meters.

The project was revised by the North China River Commission in 1932-3. Pumping was still considered as the sole solution for raising the water. The plant was to be located at Ching-chin, a village about 4 kilometers below Niu-cheng. Water would have to be raised to an elevation of 105 Taku Datum, the water surface of the river at that point being about 96. This proposition would not save any money in pumping operation, the greater saving being made on the canal system. Owing to the lack of funds and men, the project did not receive further investigation until in the spring of 1933, when the Provincial Government of Hopei had raised a certain amount of money for reclamation of farm lands and was seeking for works. The District Government of Hu-lu had also in 1932 sent a proposition on irrigation, using the same source of water, to the North China River Commission for criticism. The Hu-lu project consisted of head works at Huang Pi, a leading canal along the bank to Hsia Huang Pi, and then a canal to the farm lands. This project is almost impossible as the main current of the river attacks the south bank in that section and the building of a leading canal would involve much difficulty in foundation and protection work.

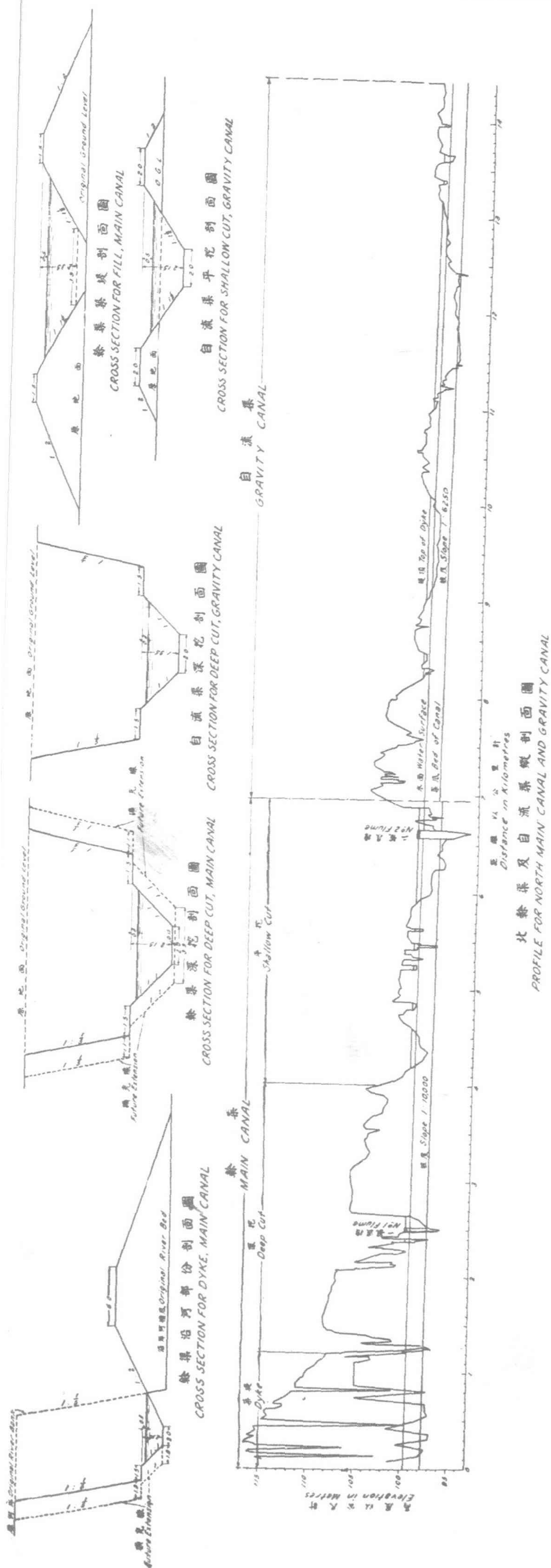
An inspection trip was made by the writer and several senior engineers of the River Commission and Construction Department of the Provincial Government. The revised plan was rejected because the proposed pumping plant was located on a shifting river course and to have the intake located on the main channel would require a culvert as long as 1,500 meters, the cost of which might cover the total sum of the revised estimate (\$210,000), without considering the silting of the culvert.

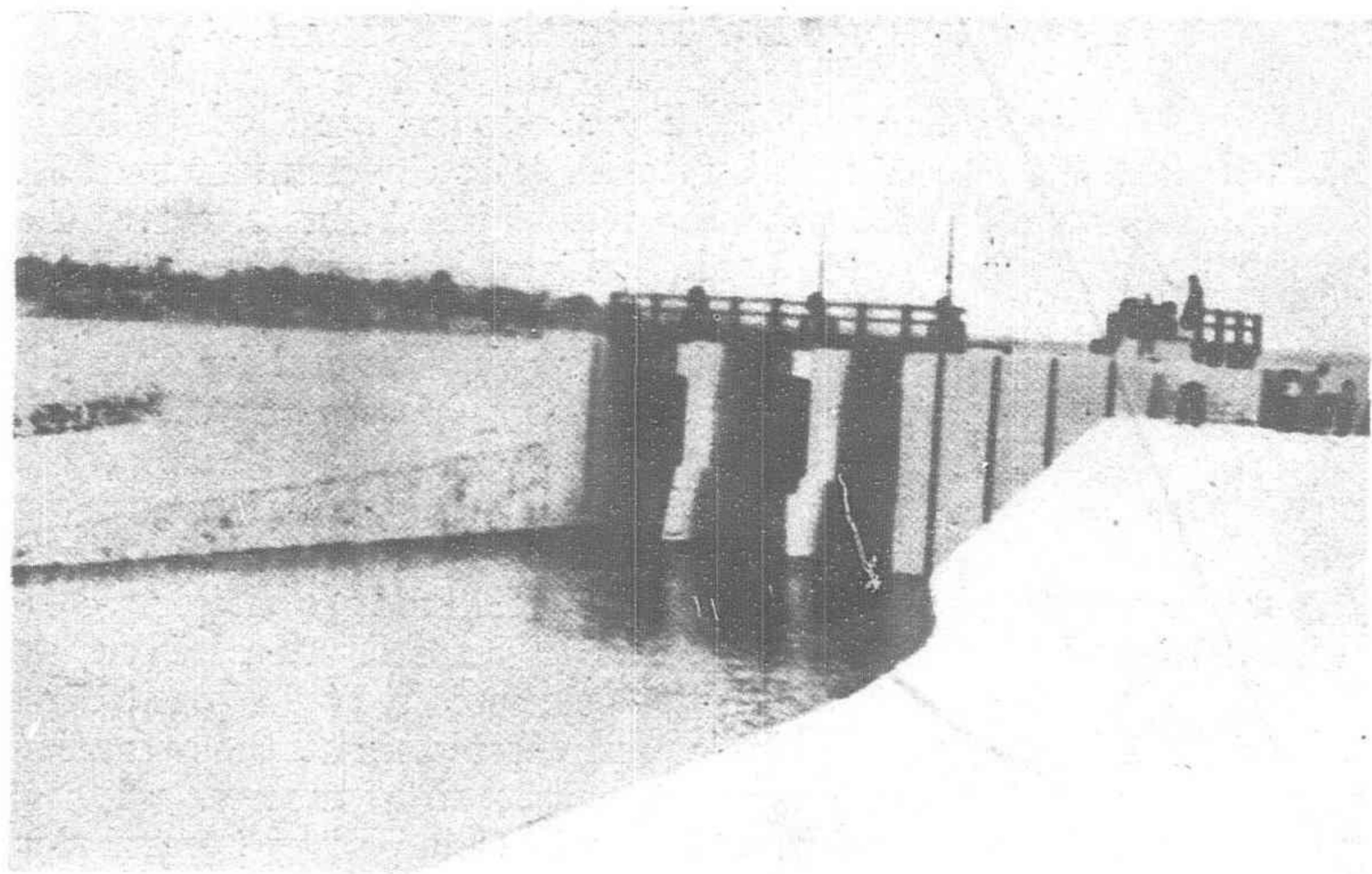
From the low water measurements, from the natural gap of the river at Huang Pi with a hill near for rock quarrying, and on account of the earnest desire of the several districts to improve their farming land by irrigation, as a final solution of the problem it was decided to raise the water surface by a low dam instead of solely using pumps.

The whole system involves the following items:

1. A rock-fill type diversion weir 434 meters long and 2.2 meters high is to be located at Huang Pi. This type is selected for the following reasons: (a) the river bed is filled with deep sand and gravel and it will cost much to reach a solid foundation; (b) rock is available at a very reasonable price while the cost of cement makes concrete construction uneconomical; and (c) with rock-fill construction, the repair work will be easy and cheap, therefore the preparation of the foundation will be more simple. The height of the weir is fixed by the elevation of the lowest cultivated land upstream the elevation of which is about 101. The crest of the dam is fixed at 100, plus 0.2 meter for settlement, so that at average flood these low farming lands will not be inundated and at higher floods these lands will be overflowed naturally.

Owing to the very porous foundation the weir is provided with a row of 6-in. sheet piles under the crest and a very flat slope of 1 on 12 is set for the downstream side. The protection of the weir at the toe is made by building several rows of wire cages filled with stone. The upstream slope or the heel is not protected except at special points. The Hu Tuo Ho carries a great amount of silt in flood times and the sudden flattening of the slope at the weir will probably deposit a great amount of silt above the dam thus forming a protection for the dam proper. The development of cross-current along the heel of the weir may be prevented by careful operation of the sluices, but further protection may be required where the cross-current occurs.





The North Sluice and part of Diversion Weir

The weir, as stated before, is of loose rock construction, except that three courses of rubble masonry wall are made with cement mortar joint, one under the crest, the other two 13.7 m. and 25.9 m., respectively from the center line. The crest, three meters wide, is also filled with cement mortar.

2. Sluices are provided at both ends of the weir. The north sluice has three openings, each three meters clear span. The south sluice has five openings of the same clear width. It is intended that the south sluice shall be used for the passage of small freshets while the north sluice is only for flushing of silt deposited before the regulator. During summer floods, both sluices shall be opened to give a quick discharge.

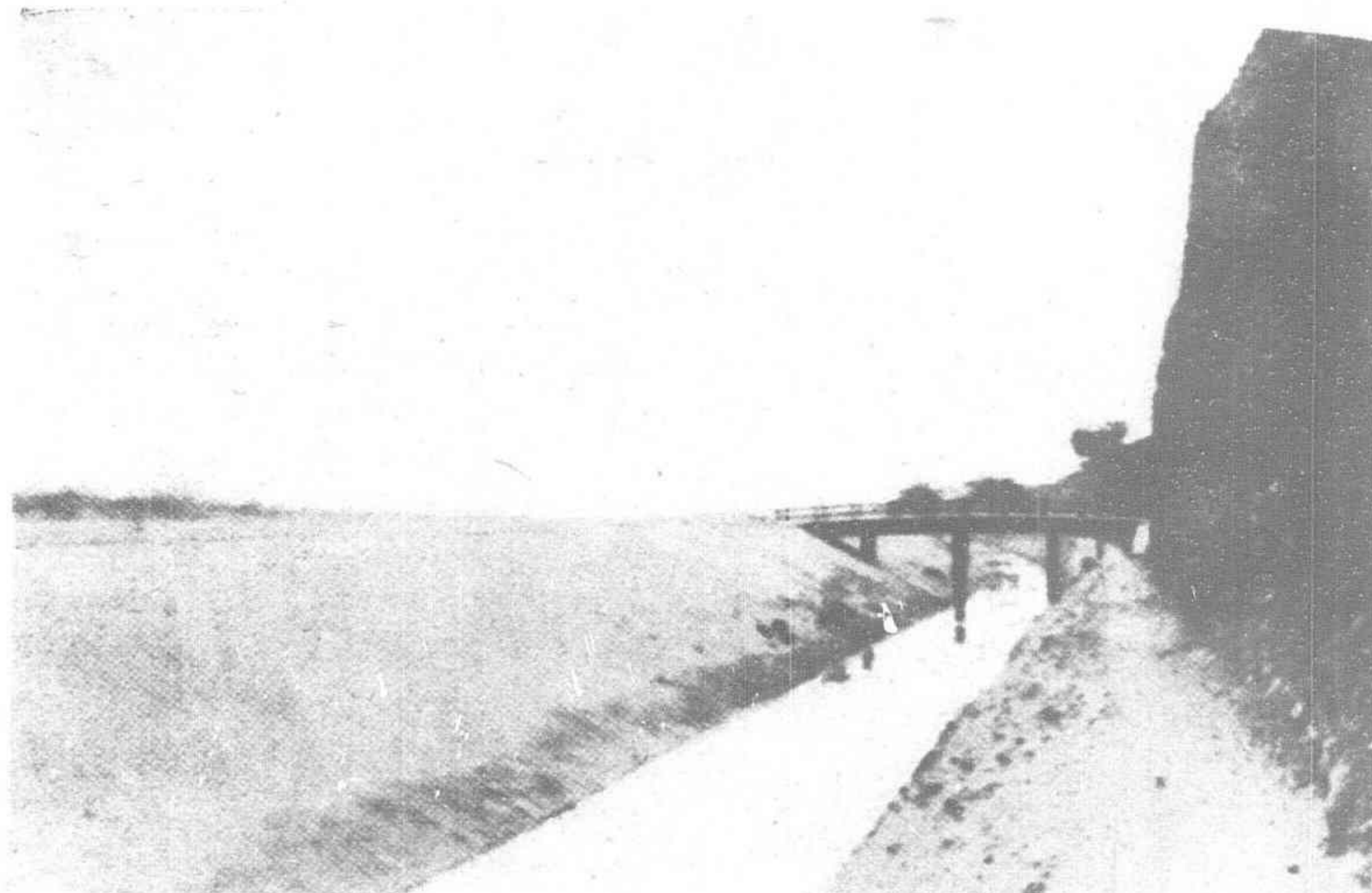
Both sluices are constructed of concrete with wooden gates for operation. The operation deck is 3.5 meters higher than the crest of the dam, as the maximum depth of water on the dam is estimated to be 2.5 meters. As the north sluice is on a porous foundation, piles and curtain walls, later changed to sheet piling owing to difficulty in construction, are provided to suit the condition. The south sluice is practically rested on rock foundation. The bottom of the sluices is set low enough, about one meter lower than the present river bed, so that during high flood the scouring of the channel below will not injure the sluice.

3. The north regulator is located at a right angle with the north sluice. It is a structure of the same construction as the sluice except that it has two openings of two meters clear width each. The high banks of the river prevent the construction of the regulator at the land and a short dike joining the abutment and the bank is provided to separate the leading canal from the river. The dike is paved with stone and protected at the foot with wire cages to prevent any chance of breaches. The capacity of the regulator is 11 cubic meters per second.

The sill of the regulator is made one meter higher than that of the sluice so that light silt deposition will not obstruct the operation of the gates. Frequent operation of the sluice is necessary, however. In the near future a sluice channel may be required not only for better action of sluicing but also as an effective measure for preventing the development of cross-current near the dam. It can be done easily by building a sort of stone dike to join the wall separating the dam and the sluices.

4. From the north regulator, the water flows to a leading canal built along the bank. At the beginning, in the design of the canal, it was intended to build a stone masonry wall at the river side, but finally the scheme was abandoned because of the prohibitive cost. Therefore, the canal is built entirely of earth dike on the river side and the natural bank on the other side. The top of the dike is one meter higher than the flood water surface as estimated before. The dike is rested for the most part on the low lands along the river, the land being protected with weeds, therefore no special protection to the dike is needed. Where the dike is more or less in danger of currents, stone paving and wire cage protection are provided.

The leading canal is a little less than one kilometer in length and has a grade of 1 in 1,000, nearly the same as the river bed. The capacity of the leading canal is the same as the regulator, that is, 11 cubic meters per second. In fact, as far as the grade of the bed is concerned, the capacity is much larger than this, so that



The Leading Canal

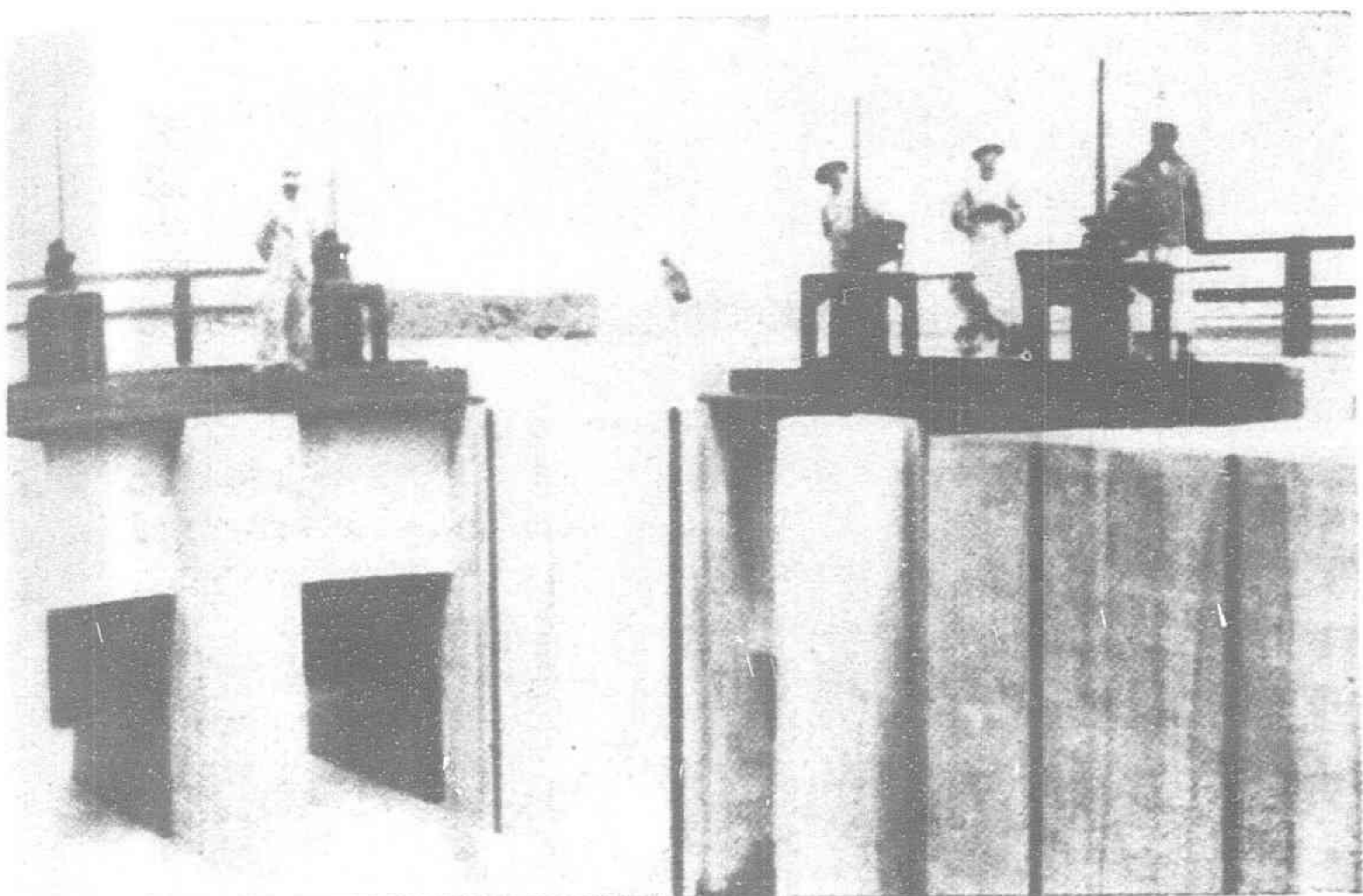
in case of flood the lower sluice located at the end of the canal may be opened to scour away any silt deposited in the canal, while during low water operation, coarse silt may be deposited in the canal before entering the main canal.

5. Another set of sluice and regulator is provided at the end of the leading canal. These structures have two functions: one to prevent coarse silt from entering the main canal as stated above, and the other to prevent flood water in case of emergency. The method of construction is the same as that of the main sluice and regulator except that the dimensions are smaller and the foundation is simpler than the main structures. These structures are located just below the village Hu-tung where the operator will live and quick action can be taken whenever necessary. The capacity of the regulator is limited to six cubic meters per second. Further extension can be made by building one or two more openings at the land side without much difficulty as the abutment on the bank side is made of stone masonry instead of concrete. At present the regulator has two openings each 1.6 meters wide. The sluice is also of two openings, the clear width of which is two meters. The capacity of the sluice is much greater than the regulator as it becomes practically a weir when in operation at low water seasons.

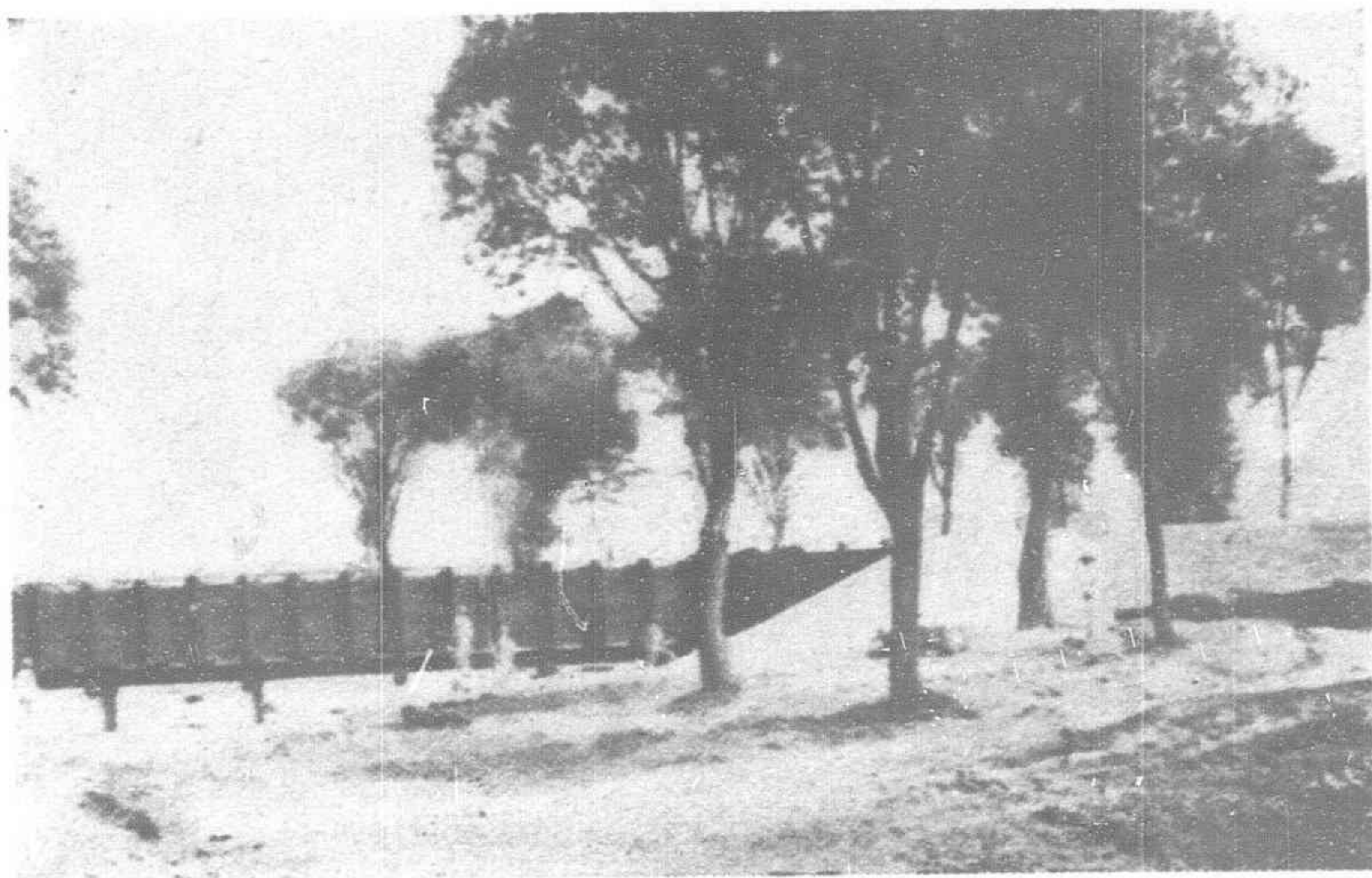
6. The north main canal begins at the lower regulator and takes a northeasterly course to the east of Lin-shou, having a total length of seven kilometers. It can be divided into three sections, the dike section, the deep cut section, and the shallow cut section. The river bank just below the regulator is still too high for cutting a canal through it. It is much more economical to build a dike along the bank than to enter the main land. The dike is built by shaving the cliff, and because of the good quality of the earth, it is as strong as necessary. The river branches to form a northern course at that section, so the dike is situated as near to the bank as possible and for the most part berm is provided at the river side. The earth required for dike construction is just enough to cut a channel for a discharge of 3.15 cubic meters per second, the discharge provided for the gravity canal of the first stage work. It can be enlarged by further cutting of the cliff and strengthening of the dike. This section has a length of 1.4 kilometers.

The second section which is 2.6 kilometers long, is entirely of deep cut except when it passes through gulleys. The deepest part is 11 meters. From the geological structure of that section and from the practice of the Kin-hui Canal and the Lung-hai Railroad, the cut is made with a slope of one vertical on 1/5 horizontal with a berm 1.5 meters wide and 0.3 meter above the water surface. The canal proper is made of a slope of 1 on 1. This design saves a lot of earth work at the beginning. Land is provided for future extension and for use in case of slide, and the earth can be removed and disposed of without difficulty.

The third section has no particular feature in design, the deepest cut being a few meters. The whole canal is designed with a grade of 1 on 10,000, which seems to be too flat for an irrigation canal. However, the Hu Tuo Ho is practically clear during the low water season, therefore no silting is feared. Even if silt contents are increased during the freshet, the leading canal has ample capacity for them to deposit; and any amount entering the lower regulator, the sill of which is 0.6 meter higher than the bottom of the leading



The Lower Regulator (Gate opened) and Sluice



Flume No. 1

canal, will probably do no harm. The use of this flat gradient has still other objects in saving both the head available and the cost of earth cut. The capacity of the canal is provided differently at different sections : sections entirely of cut, 3.15 cubic meters per second ; sections partly of cut or entirely of fill, six cubic meters per second ; flumes, etc., six cubic meters per second. This provision is made not only with the aim of saving the construction cost at the beginning, but also of making the change at future extensions as small and cheap as possible, as the money available is barely enough to complete the so-called gravity canal of the first stage work.

The main canal crosses two large creeks on its way. Wooden flumes with a capacity of six cubic meters per second are used to bring the water over these creeks. Nine bridges of different types are provided to connect roadways.

7. The gravity canal is merely an extension of the main canal, with a steeper grade (1 on 6,250) and a smaller cross-section. At the beginning of the gravity canal is a pumping plant raising water to the first pumping canal. The gravity canal irrigate land below elevation 98 and the first pumping canal is provided for land between elevations 105 and 98.

The following table shows the provision for the whole plan in regard to the capacity of flow and area of land to be benefited.

Structure	Capacity c. m. s.	Area of land Benefited in Mou	District Concerned
Diversion Work .. ..	16	355,000	Lin-shou, Cheng-ting, Hu-lu, Hsin-tang, Hsin-lo, Ping-shan
North Leading Canal ..	11	244,000	Lin-shou, Cheng-ting, Hsin-tang, Hsin-lo
Main Canal in Cut ..	3.15 (to be enlarged to 6 c. m. s. in the near future)	70,000 (to be enlarged to 133,200 in the near future)	Lin-shou, Cheng ting
Main Canal in Fill and Flumes .. ..	6.00	133,200	Lin-shou, Cheng-ting, Hsin-tang, Hsin-lo
Gravity Canal .. ..	3.15	70,000	Lin-shou, Cheng-ting
First Pumping Canal ..	2.85	63,200	Lin-shou, Cheng-ting, Hsin-tang, Hsin-lo

The provision is made to irrigate land once every 15 days with  $7\frac{1}{2}$  cm. of water, plus 25 per cent for loss by percolation. This may be changed to once every 10 days with five cm. of water if necessary. The area irrigated is much less than that provided by the Kin-hui Canal System. Probably it can be extended without much extra cost, if from experience, the amount of water needed is less than that provided.

The economy of this scheme as compared with the pumping system above stated and separate diversion work for the south canal, is quite evident. Firstly, by pumping alone, the intake should be built near the south bank as the river takes a southern course at that section except near Niu-cheng, where the high bank prohibits the construction of a canal system. Even at Huang Pi, where the banks converge to form a narrow gap, it would require a long culvert of about 400 meters to bring water to the north bank. Including the intake work, a bridge to reach the intake, and the pumping pit at the end of the culvert, the whole structure would cost as much as one-third to one-half of the diversion work, as concrete construction would be absolutely necessary instead of loose rock construction. The capacity of the culvert would be, of

course, limited to the present requirement or at most six cubic meters per second. To raise six cubic meters of water through a net head of 2.2 meters would require a gross power of at least 250 h.p. The additional cost of a pumping plant would cover nearly another one-third of the diversion work. The final one-third, about \$80,000, would be much less than the capitalized operating expense for a 250 h.p. pumping plant.

Secondly, it would require additional expense to expand the scheme, just as much as is needed at the beginning, if only pumping is used. The building of a diversion dam provides for a capacity nearly twice as large, without increasing the cost. This additional capacity of five cubic meters per second may be used entirely for a gravity system, and it may be accomplished with little extra work. Even if it is needed to irrigate higher lands, the saving in the pumping of another five cubic meters per second through a head of 2.2 meters will amount to quite a big sum.

Thirdly, the south canal system can be built easily and cheaply by the construction of this diversion work. A natural waterway can be utilized for the main canal, only a short distance requiring additional cut. This cannot be done if the water surface is in its natural and fluctuating states.

In a word, the present scheme is more flexible and economical than what was ever proposed before, even though a few more tens of thousands of dollars are required than at first. The crest elevation is limited by the land lying above, but this may not be a serious handicap to the system, as additional height of the weir may increase the cost to such an extent as to over-balance the cost of pumping plant and canal earth work. Many things will be determined later, as provision of shutters, the construction of sluice way, etc.

### The Construction

As soon as the detail survey and plans were completed the work was started in September, 1933. Separate contracts were signed to take care of different kinds of work : two contracts for main and gravity canals, one for rock quarrying, one for diversion work and leading canal, one for gate and operating machinery, and a sixth for miscellaneous structures. A special price for cement and a special rate for transportation by rail were negotiated before the award of contracts. The materials for the sixth contract were also supplied by the Hu Tuo Ho Irrigation Bureau.

For the supervision of the work, a commission of five members was organized under the jurisdiction of the Provincial Government. Each member represents one of the following organizations : the Civil Department, the Construction Department, the Industrial Department and the Finance Department of the Provincial Government, and the North China River Commission. Under this commission, the Director of the Hu Tuo Ho Irrigation Works took charge of the whole job. Two division engineers were installed for carrying out diversion and canal works respectively. All the engineering staff came from the Construction Department and the North China River Commission, paid with a small allowance to cover their field expenses, their salaries still being paid by their respective organizations.

The work was planned to be completed on June 15th before the summer freshet came. Owing to difficulty met in the construction

(Continued on page 479)

# Singapore's Sewage Project

SINGAPORE Municipality has decided to raise an \$8,000,000 loan to perfect the sewerage of the town.

New disposal works are to be constructed at Paya Lebar. The outflow is to be poured into Serangoon River and by bio-flocculation treatment will be entirely free from smell.

At present the Municipality are committed to a \$2,000,000 loan at 4½ per cent. The balance outstanding on this will be cancelled. A new loan of \$8,000,000, subject to Government's approval, will be raised, half forthwith.

Only \$5,500,000 of this new \$8,000,000 loan is intended for sewerage, the balance of the expenditure, providing for the construction of minor sewers, to be raised, again if permitted, on expenditure from revenue and a short term loan. The \$2,500,000 balance on the actual loan is to cover certain electrical charges and the completion of the ring road.

If Government approves of the huge new loan, the finance committee, in recommending ways and means of raising half forthwith, have been instructed not to pay more than 3½ per cent interest.

No acrimony whatever marked the discussions, all the Commissioners present at the meeting—it was a special meeting to discuss the matter alone—being quick to agree that Singapore should possess an up-to-date sewerage system.

The details of the scheme were considered in general committee to which the Press was admitted.

In a preamble to determine whether the Commissioner agreed to the adoption of any scheme, the President (Mr. W. Bartley) said there were four schemes in all. These had been drawn up by the staff and consulted upon by an expert from Home, Mr. J. D. Watson.

There was one point he wished to make perfectly clear. All the schemes provided for the total elimination of crude night soil from the Alexandra Road works. This had been their main trouble in the past.

## Change of Method

The scheme which had been recommended by the consultant represented, too, a complete departure from their present method of sewerage purification. Water-borne sewerage would be treated roughly as at present but in respect of the crude night soil, instead of mixing it with the water-borne sewerage, the solids later taken out and re-treated, it would be pumped direct to the dry purification beds. The tritus which remained in the Alexandra Road works would be pumped out, mixed with the night soil and would help to digest it on the site of the new works, wherever they might be.

With regard to the effluent, the recommendation of the committee, which had considered the schemes, was that bio-flocculation units should be interposed between the tanks and the final outflow into Serangoon River. The effluent would then be odorless and contain only about five parts of suspended matter in 100,000.

Before the Commissioners signified their desire to proceed with a sewerage scheme Mr. S. H. Moss directed their attention to the financial aspect. The usual way to finance a scheme of this sort was to raise a loan which would cover the whole capital charge. In view of the low interest rates obtaining at the moment he would suggest that the loan be raised at once and not issued as the money was needed. He was sure they could obtain their money at three per cent to-day.

If they issued only \$1,000,000 this year it might be that by the time they wished to issue more, interest rates would not be the same. The loan should be spread over a period of longer than 40 years. They would not be paying for posterity then.

Having decided to proceed with a scheme, the Commissioners then agreed to accept the Consultant's scheme in principle, this not binding them to accept it in detail. This scheme provided for the construction of a new disposal works on the north side of the island, the effluent to flow into Serangoon River or alternatively into the Johore Straits.

Before this step was taken, however, the President was closely questioned by Mr. J. Laycock regarding the notice paid in the summary of the proposals, laid on the table to "aerial nuisance," which he presumed, meant smell.

He pointed to the fact that a cablegram had been dispatched to the Consultant through the Home Agents reading "Commissioners anticipate strong public opposition to Paya Lebar for sewage works owing to recent aerial nuisance from Alexandra Road. With one hour's bio-flocculation to counteract extra septicization would Consultant agree to siting sewage works at Serangoon instead of Paya Lebar? The cabled reply from the Home Agents was: "Referring Municipal Engineer's cable. . . . Consultant stages one hour's bio-flocculation would not succeed. There would be no nuisance at Paya Lebar if works are well designed and operated. Air letter following.

The references to aerial nuisance pointed to the fact, said Mr. Laycock, that there would or might be some smell which would or might cause some nuisance. He would put it no higher than that. If it did create a nuisance they laid themselves open to action from people with surrounding property. Not only that but it was their duty to avoid a nuisance now that the possibility had been suggested.

## Odorless Effluent

Mr. Bartley pointed out that by bio-flocculation the effluent at least, would be odorless, while their Consultant (and here he read the air mail letter) was of the opinion that there would be no smell from the disposal works themselves if they were well designed and operated. He believed their own staff were not prepared to be so dogmatic in regard to the disposal works.

Mr. Fraser: There will be some smell on the works but not beyond it.

Mr. Laycock: I see it is advocated elsewhere that there should be a belt of trees round the works.

The President: That is provided for in the scheme.

The scheme having been adopted, the next point to be decided was whether the disposal works should be at Paya Lebar or further down Serangoon River and in this connection the President pointed out that the Consultant definitely recommended against moving the works further to the coast.

This point, together with the fact that the outfall might either be in Serangoon River or in the Johore Straits caused Mr. Laycock again to seek an assurance that no nuisance would be caused.

It was pointed out in regard to the first point, that there would be no difference in the nature of the effluent but the Consultant regarded it as essential that the sewage should be freed of its solid impurities at the earliest possible moment. Outflow into the Johore Straits meant the laying down of a long pipe line. Bio-flocculation would not of course, be required. Outflow into Serangoon River, with bio-flocculation, was preferred.

## One Better

Mr. Tay Lian Teck said it seemed their own experts had gone one better than the expert from Home in recommending bio-flocculation.

Mr. L. W. Geddes asked if the outflow would cause vegetable growths in the river.

The President said he did not think so, while he was informed by the Fisheries Department that it was good for the fish!

It was then decided that the disposal works should be located at Paya Lebar, the outflow to go into Serangoon River after bio-flocculation.

Discussion then followed regarding the financial aspect of the question and objection was raised by Mr. Moss and Mr. C. C. Dunman to the proposal to float loans as the money was required.

Mr. Moss was of the opinion that the whole of the loan should be floated at once—after they had satisfied themselves that Government would agree and that the money would be subscribed—calling up parts of it as and when required. Mr. Dunman thought it would be sufficient to float only half the loan at once.

The Treasurer, Mr. J. Stone, said he did not think Government would agree to Mr. Moss's proposal.

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## New Vessel Launched in Denmark for Service in the Far East

ON Saturday, August 11, 1934, the motor-ship *Jutlandia*, built to the order of Messrs. The East Asiatic Company, Copenhagen, was successfully launched at Nakskov Skibsværft, Nakskov, Denmark.

The principal dimensions are:

Length between perpendiculars ..	425-ft.
Breadth mould .. .. .	61-ft.
Depth to upper-deck .. .. .	36-ft.
Carrying capacity .. .. .	about 10,000 tons d.w.

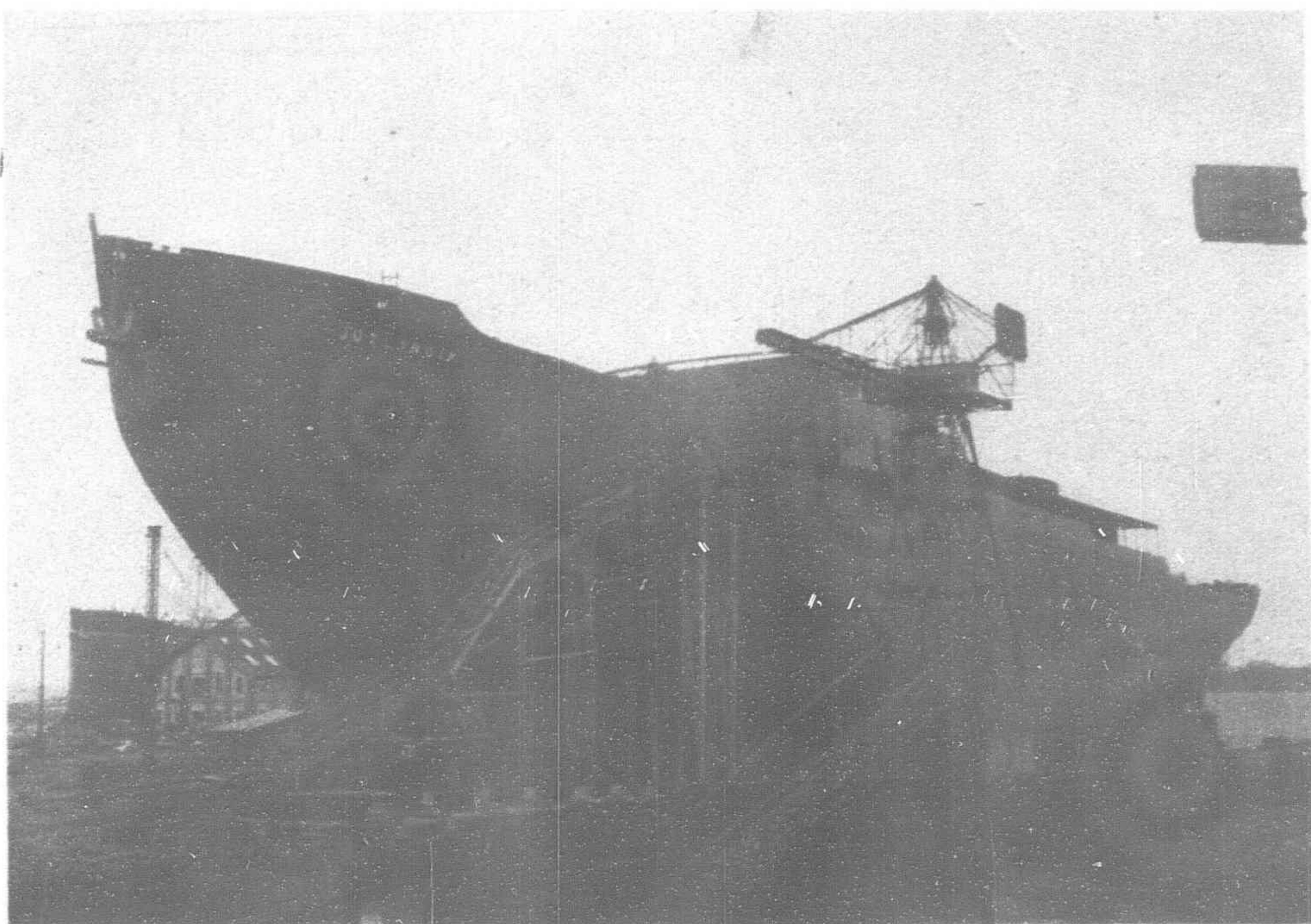
The ship is built to British Lloyd's highest class and complies with the rules laid down by the London Convention of 1929, for passenger-ships.

It is the first ship with *Maier*-stem in the fleet of The East Asiatic Company, is built as "Complete Superstructure" ship with poop, long bridge and forecastle, with seven watertight bulkheads, all carried through to the upper deck, and with double-bottom in the whole length of the ship.

She is fitted with five hatches, four masts and six derrick-posts; seventeen derricks, ten of which can lift five tons, two-ten tons, one-forty tons and four-three tons; sixteen electrical winches are fitted, ten of which can lift three tons, two-five tons and four-seven tons, two electrical capstans on the poop, and electrical windlass. All the deck auxiliaries are supplied by Messrs. Thomas B. Thrige, Odense, Denmark, which firm also supplies the electrically driven steering gear.

The ship is built as a passenger—and cargo—motorship specially designed for The East Asiatic Company's regular route to Bangkok, and is equipped for a larger number of passengers (total 59).

The cabins and saloons will be arranged and equipped more comfortably than the previous ships built to this route. Each



The New Motorship "Jutlandia"

passenger cabin is arranged with detached bed and adjoining bath-room, and the dining-saloon on upper deck, the smoking-saloon and the ladies-saloon on the bridge deck are all fitted out in a high class modern style.

The smoking-saloon will be fitted with a bar, and on the upper deck there will be a separate dining-saloon for children adjoining to the dining-saloon.

The propelling machinery consists of two Burmeister and Wain double-acting two-stroke diesel engines of a total of 7,850 i.h.p., giving the loaded ship a speed of 16-17 knots.

After the launching, the ship, which is one of the greatest launched from Nakskov Shipyard, was moored at the builders' fitting-out quay to have her engines installed and the equipment completed for the delivery, which will take place in the beginning of November this year.

## The Design and Construction of the Hu Tuo Ho Irrigation System

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of the foundation, the head works were only partly finished by that time. It would not be wise to run the risk of being flooded when still in construction, so the work was discontinued until next fall. For the sake of economy, it was proposed that the first pumping system should be started jointly with the unfinished part of diversion work so that next spring the works planned for the first stage would be completed. At present the finished work may be listed as below:

1. The north sluice and regulator
2. The leading canal
3. The lower sluice and regulator
4. The main canal (14 kilometers)
5. The laterals (total about 14 kilometers)
6. Flumes, bridges, check gates, etc.

The diversion dam is only partly finished, special protection for the head of exposed and being provided.

The construction was done in most cases by hand labor. This included paving the dam surface with stone blocks as heavy as one ton or more. Modern appliances used in construction were of but few kinds. Pumps and light tracks and cars made up this list. The transportation of heavy machinery was very costly, but local labor was very cheap. This method, however, delays greatly the progress of construction. The local laborers live on the bare minimum of food, which makes them physically very weak. The only earth work done solely by local workmen was that of the laterals, shallow cut of loam and loess, under a contracted price of 16 cents per fang. Heavy cut of miscellaneous earth,

including a part of conglomerate, was done by experienced laborers from other districts.

As the work is not completed and the operation of the irrigation system is not started, the writer is not yet in a position to make any concrete conclusions as to the success of the scheme. The writer fears that the paper contains very few engineering features of special interest, but he will always welcome any criticisms and suggestions from fellow engineers for the good of the work.

## Singapore's Sewage Project

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Mr. Laycock said the point was that it was felt that as business improved more and more money would go into trade and they would not be able to get the same interest rates later.

The President said there was one financial expert who considered that money would get cheaper if anything.

Mr. Dunman's proposal was put to the vote and carried by a majority of one. The voting was six to five, the President voting against. Subject to Government's approval, therefore, it was decided to raise a loan of \$8,000,000, half forthwith. It was left to the finance committee to consider ways and means of raising the first \$4,000,000, interest not to exceed 3½ per cent. The period of the loan, it was agreed, should be 50 years. The maximum under Statute is 60 years.—*The Times of Malaya*.

# Engineering Notes

## INDUSTRIAL

**SULPHATE PLANT FOR HUNAN.**—Mr. Fan Yu-tung, a Hunanese millionaire, has been granted the right to erect an ammonia-sulphate plant in Hunan on condition that it be completed within 1½ years. The plant is to be capitalized at \$10,000,000. With this development, the Ministry of Industries has discarded its efforts to enter into such an enterprise with the aid of foreign capital. The Ministry had been negotiating with British and German chemical interests with a view to inviting their co-operation.

**PULP FACTORIES FOR MANCHURIA.**—Daido Forestry Co., Manchoukuo, is to be founded with a capital of Y.5,000,000. The concern will be charged by the Government with the exploiting of forest lands in Kirin Province. To-day there are three Japanese organizations trying to get a forestry franchise in Manchoukuo, to engage in pulp manufacturing on a large scale. They are the Okawa, the Oji Paper and the Kawanishi interests. Okawa has a plan to establish the East Manchuria Rayon Pulp Co. with a capital of Y.10,000,000.

**HARBIN'S NEW CIVIC PLAN.**—According to the Harbin Press, the administration of Greater Harbin intends to open negotiations with the Central Bank of Manchoukuo for a \$20,000,000 loan to be used for the construction of a water-works and also for the purchase of all land within the environs of the town. In Pristan and New Town nearly all land is held on lease concluded with the Chinese Eastern Railway. Some surprise is expressed that the Municipality contemplates such a project, for it appears that until the leases expire no party has the right to sell any land.

**PUBLIC WORKS IN CANTON.**—The Municipal Government at Canton, which is encouraging reconstruction and industry in a very practical manner, is able to report favorable progress. Undertakings completed this year are the Tungshan filtering plant, with a daily output of 1,000,000 gallons, a water-reservoir, a bazaar in the Eastern Suburbs, the building of east Laichwan Road, etc. The foundations have been laid for another electric power-plant near the Sai-Chuen cement works, which will be completed in five months. A very comprehensive road-building scheme has been undertaken, which will eventually extend from the Honam side of the Pearl River past Lingnan University to a point near Whampoa, completing a large circle by returning on the other side of the island. The scheme will open up much territory between Honam and Lingnan. New factories in process of construction include a sodium factory, sugar refinery, hemp filature, brewery, paper mill, steelworks, textile works, etc. A hydro-electric power house is also being built.

decided to undertake work on the Kasagi Power station (capacity 35,500 kw.), the Sasado power station (capacity 9,000 kw.), and the Miura reservoir along the Kiso River. At the same time the proposed amalgamation of the Osaka Electric Power Co. by Daido Power was decided upon. Osaka Power, capitalized at Y.10,000,000, supplies 251,140 lamps, 47,177 h.p. and 1,797 kw.

**ELECTRIC POWER IN JAPAN.**—Toshin Electric Company has drawn up a plan to exploit 60,000 kw. of power by erecting power stations at Shogamine and Shiotsubo along the upper reaches of the Akano River. Work is to begin some time next November.

## COMMUNICATIONS

**WIRELESS AS STANDBY.**—Wireless apparatus is to be installed in the telegraph offices of all important cities in Japan, says Reuter, in order to ensure smooth-working communications in any emergency. This step has been taken by the Ministry of Communications as a result of the experience of the serious conflagration at Hakodate, in which all land wires, which were the only means of communication, were destroyed.

**RADIO-AGREEMENT.**—The Tokyo Ministry of Communications and Mr. C. C. Chapman, representative of the Mackay Radio Co. of America, have signed a formal agreement for the establishment of another wireless route between Japan and the United States. The new route is expected to be in operation in the coming autumn. The Mackay Radio Co. already is operating between Shanghai and San Francisco.

## ELECTRICAL

**A "GRID" FOR JAPAN.**—The Electric Power Federation of Japan recently drafted a plan for the establishment of a power transmission network. Companies included in the plan are Tokyo Light, Toho Power, Daido Power, Nippon Power and Ujigawa Electric, known as the "Big Five" power firms, and their affiliated concerns such as Toshin Electric, Jomo Power, Kwanto Hydro-Electric, Fuji Power No. 2, Gumma Hydro-Electric, Yahagi Hydro-Electric, Godo Electric, Nankai Hydro-Electric and Chubu Power. The initial program calls for construction of many power stations on a five-year plan beginning this year. Daido Electric Power has

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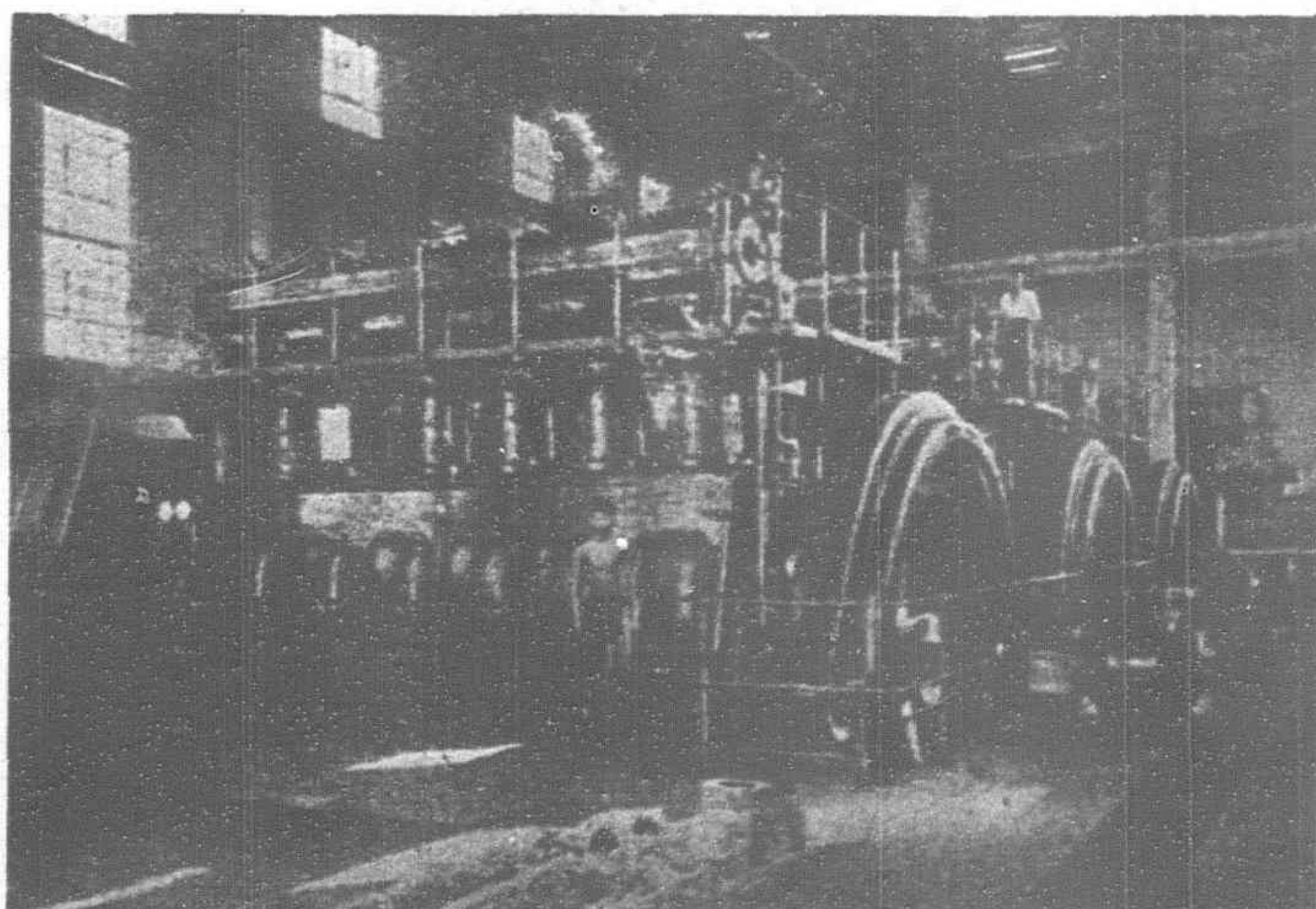
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